U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-298 612

A Workforce and Training Profile for Solid Waste Management and Resource Recovery

National Field Research Center, Inc, Washington, DC

Prepared for

Environmental Protection Agency, Washington, DC Office of Research and Development

1979

EPA-600/8-79-024
August 1979

PB 298612

A WORKFORCE AND TRAINING PROFILE
FOR
SOLID WASTE MANAGEMENT AND RESOURCE RECOVERY

conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.

Washington, D.C. Office
1522 K Street, N.W., Suite 600
Washington, D.C. 20005

under grant from:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Grant No. T900591-03

1979

Project Staff:
Mr. Jack F. Seum, Project Director
Dr. Darold E. Albright, President
Mr. Robert D. Oxberger
Mr. Gary S. Lance
Ms. Linda Bardelmeier

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/8-79-024	2.	3. RECIPIENT'S ACCESSION NO. PB 298 612
4. TITLE AND SUBTITLE A WORKFORCE AND TRAINING PROFILE FOR SOLID WASTE MANAGEMENT AND RESOURCE RECOVERY		5. REPORT DATE August 1979 issuing date 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) National Field Research Center, Inc.		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Field Research Center, Inc. 1522 K Street, N.W., Suite 600 Washington, D.C. 20005		10. PROGRAM ELEMENT NO. 2BC651 11. CONTRACT/GRANT NO. T900591-03
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Office of Research and Development (RD-680) 401 M Street, S.W. Washington, D.C. 20460		13. TYPE OF REPORT AND PERIOD COVERED Final Report, 1979 14. SPONSORING AGENCY CODE EPA/600/19

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report, authorized as mandated in Section 7007(c) of the Resource Conservation and Recovery Act of 1976, is divided into the following topics: (1) a workforce profile and analysis section studying the workforce needs of public and private agencies involved in solid waste management and recovery; (2) a section analyzing what are considered by sources in the field to be the principal blockages to initial employment and career advancement in solid waste management; and (3) an analysis of the U.S. Environmental Protection Agency's responsibilities for workforce development and training activities.

Information in the report was obtained primarily from personal, on-site interviews with officials directly involved in solid waste management, including officials at Federal, State, and local levels; representatives from the private sector and from professional associations; and academic officials connected with postsecondary educational programs in solid waste management.

[illegible]7. KEY WORDS AND DOCUMENT ANALYSIS

DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
[illegible]ironmental Protection Agency Solid Waste Management Refuse Disposal Manpower Environmental Engineering Environmental Education Environmental Protection Pollution Control Planning State Planning Federal Government Planning Labor Force Forecasting Employment Energy Management Environmental Management		05/D 05/I

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 164
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE PC A08 / MF A01

EPA Form 2220-1 (9-73)

DISCLAIMER

This report has been reviewed by the Office of Research and Development, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

TABLE OF CONTENTS

Page

TABLES iv

ACKNOWLEDGEMENT v

FOREWORD ix

BACKGROUND 1

METHODOLOGY 3

INTRODUCTION 4

SUMMARY OF FINDINGS AND RECOMMENDATIONS 5

WORKFORCE PROFILE AND ANALYSIS 15

- Public Sector 15
- Private Sector 27
- Hazardous Wastes 32
- Resource Recovery 38

OBSTACLES TO EMPLOYMENT/ADVANCEMENT 45

TRAINING 49

- Public Sector 49
- Private Sector 69
- Universities 79
- Hazardous Wastes 86
- Resource Recovery 104
- Certification 108

REFERENCES 119

APPENDICES 122

A. Saugus, Massachusetts Resource Recovery Plant Job Descriptions 122
B. Solid Waste Training Grant Awards to State and Local Agencies 132
C. Training Programs Sponsored By Private Sector Organizations 135
D. Solid Waste Training Grant Awards to University Academic Programs 138
E. Colleges and Universities Offering Solid Waste Management Training 141
F. Bibliography 150

Special acknowledgement is given to Ms. Margie V. Gardner
for the original artwork contained in this volume.

and to Dr. P. Aarne Vesilind of Duke University
for the use of photographs in this volume.

TABLES

TABLE	TITLE	PAGE
1.	Solid Waste - Workforce Projections by State, 1976-1982. .	19
2.	State Solid Waste Workforce Projection Study	22
3.	Employment and Distribution of Local Government Solid Waste Management Personnel in 1972.	25
4.	Projections of Local Government Workforce Growth in Solid Waste Management.	26
5.	Distribution of Solid Waste Management Personnel in the Private Sector, 1972	29
6.	Projected Private Sector Workforce Requirements in Solid Waste Management to 1986	30
7.	Private Sector - Disposal Workforce Projections 1976-1981	31
8.	Estimated Employment in the Hazardous Waste Management Industry in 1975.	36
9.	Workforce Profile - Saugus, Massachusetts Resource Recovery Plant.	43
10.	Locations of Major U.S. Resource Recovery Facilities . . .	44
11.	Solid Waste Training Awards.	55
12.	EPA Funding and Staff for Manpower Development and Training Programs	57
13.	Summary of EPA Regional Office Solid Waste Activities .	61
14.	University/College Programs with Training in Solid Waste Management	85
15.	Categories of Personnel Requiring Training and Training Needs.	91
16.	Categories of Personnel Requiring Training and Anticipated Delivery Systems.	93

ACKNOWLEDGEMENT

Grateful appreciation is expressed to the individuals and organizations who participated in this project with contributions of both time and assistance. Without their support, this report could not have been produced. Of particular note is the assistance and direction provided by the Environmental Protection Agency staff - Mr. J. Donald Cook, the project officer, of the Office of Research and Development, Ms. Carol Lawson and Ms. Gladys Harris of the Office of Solid Waste, and Mr. Raul Zaltzman of West Virginia University, on leave to the Office of Solid Waste. Additionally, the review and comments on the draft of this report by Ms. Carolyn Barley, Mr. John P. Lehman, Ms. Emily Sano, and Mr. John W. Thompson of EPA's office of Solid Waste are sincerely appreciated.

The many others who participated through personal or telephone interviews are indicated below in alphabetical order.

Dr. Ronald Alvarez
Hofstra University

Ms. Carolyn Barley
EPA Office of Solid Waste

Mr. Ralph Black
EPA Office of Solid Waste

Mr. William S. Bristow, Jr.
Saugus, MA Resource Recovery Plant

Mr. Elmer Cleveland
EPA Atlanta Regional Office

Mr. Clifford Cobb
National Association of Counties

Mr. Thomas J. Cunningham, Jr.
National Center for Resource Recovery

Mr. Jack Dunn
American Public Works Association

Mr. Richard Eldridge
Waste Age Magazine

Dr. Richard Englebrecht
University of Illinois

Mr. Donald Fagen
EPA Office of Solid Waste

Mr. A. Allen Galli
EPA Office of Research and Development

Mr. Walter Gilbert
EPA Environmental Training Center, Cincinnati

Dr. Eugene Glysson
University of Michigan

Mr. Andrew Goddard
EPA Office of Solid Waste

Mr. Paul Green
Institute of Scrap Iron & Steel

Mr. Richard L. Hanneman
National Solid Waste Management Association

Mr. William Holland
EPA Atlanta Regional Office

Mr. Andrew Holton
Maryland Department of Health & Mental Hygiene

Dr. Charles Johnson
National Solid Waste Management Association

Mr. James L. Kopplin
Baltimore City Pyrolysis Plant

Mr. Louis Lefke
EPA Environmental Research Center, CIncinnati

Dr. Joseph F. Malina
University of Texas

Mr. Paul Marsh
Black Clawson Company

Ms. Terry Mathews
National Governor's Association

Mr. Edward J. Moore
Baltimore Department of Public Works

Mr. Peter Mooij
Americology Resource Recovery Plant, Milwaukee

Mr. Kenny Moravetz
Ames, Iowa Resource Recovery Plant

Mr. John Neal
Franklin, Ohio Resource Recovery Plant

Mr. Howard Ness
National Association of Recycling Industries

Mr. Edward. Newell
U.S. Army Environmental Hygiene Agency

Mr. Phillip Nowers
National Solid Wastes Management Association

Mr. Allan Pierce
EPA Office of Solid Waste

Dr. Frederick G. Pohland
Georgia Institute of Technology

Mr. Milton Radke
Texas Engineering Extension Service

Dr. Alan E. Rimer
Duke University

Mr. James Scarbrough
EPA Atlanta Regional Office

Dr. James H. Schaub
University of Florida

Mr. Peter Siefart
Black Clawson Company

Ms. Gail Silverman
Parson and Whittemore, Inc.

Mr. Orville Stoddard
Colorado Department of Health

Dr. P. Aarne Vesilind
Duke University

Major David Warner
U.S. Army Environmental Hygiene Agency

Mr. William H. Wechter
American Society of Mechanical Engineers

Mr. Eugene Weingerter
National Solid Wastes Management Association

Mr. Ronald G. Wriston
Baltimore County Solid Waste Disposal System
and Reclamation Project

FOREWORD

This report is a profile of the workforce and training aspects of the solid waste management field. It offers a view of both the capabilities and needs that currently exist and presents an analysis of the information and opinions that are available to date. The report responds to Section 7007 (c) of the Resource Conservation and Recovery Act of 1976 which identifies the need to determine: 1) workforce requirements, 2) training capabilities, and 3) the nature and extent of obstacles to employment and advancement, all of which affect the ability of the federal, state and local governments to comply with the provisions of the Act.

To the greatest extent possible, all previous studies on the subject of Solid Waste Management and Resource Recovery and all relevant background materials were reviewed during the preparation of this report. These are listed in Appendix F, the Bibliography. Additionally, contacts were made or attempted with all identified individuals and organizations having expertise in solid waste management/resource recovery workforce and training and those persons are listed in the Acknowledgement section. The data collected were then analyzed in the light of current federal policies and guidelines and seek to represent a current composite of solid waste management information available at the time this study was conducted (August-November, 1978). Some projections of future workforce requirements are based on data from previous studies and assumptions are made about growth rates remaining constant. These projections should be regarded as possible scenarios for employment growth.

BACKGROUND

The Resource Conservation and Recovery Act of 1976 (Public Law 94-580 or RCRA) was passed by Congress on October 21 of that year as an expanded replacement of two earlier pieces of legislation, the Solid Waste Disposal Act of 1965 and the Resource Recovery Act of 1970. The enactment had the specific purpose of providing "technical and financial assistance for the development of management plans and facilities for the recovery of energy and other resources from discarded materials and for the safe disposal of discarded materials, and to regulate the management of hazardous waste."

To achieve its objective of promoting "the protection of health and the environment and to conserve valuable material and energy resource," the Act requires that the Environmental Protection Agency determine:

"(1) the need for additional trained state and local personnel to carry out plans assisted under this Act and other solid waste and resource recovery programs;

"(2) the means of using existing training programs to train such personnel; and,

"(3) the extent and nature of obstacles to employment and occupational advancement in the solid waste disposal and resource recovery field which may limit either available manpower or the advancement of personnel in such field." That is the purpose of this report.

Involvement on the part of the National Field Research Center (NFRC) in the area of environmental research on solid waste dates from 1976, when NFRC began a three-year National Environmental/Energy Workforce Assessment. Currently in its third phase, the study has examined the areas of air, noise, pesticides, potable water, radiation, solid waste, wastewater, and energy.

METHODOLOGY

The information contained in this report was obtained primarily from personal, on-site interviews with officials directly involved in solid waste management and resource recovery. This includes government officials at the federal, state, and local levels; private sector officials from professional associations and industry; and academic officials connected with postsecondary educational programs in solid waste management. These individuals were interviewed about such topics as present employment opportunities, potential opportunities, job trends, training needs, and obstacles to employment and advancement in the solid waste management field. Where personal interviews were not possible, individuals supplied information for the study over the telephone or by mail.

Attempts have been made to obtain information specifically in the following areas:

(1) the need for additional trained state and local personnel to carry out plans assisted under RCRA and other solid waste and resource recovery programs;

(2) the means of using existing training programs to train such personnel;

(3) the extent and nature of obstacles to employment and occupational advancement in the solid waste disposal and resource recovery field which may limit either available manpower or the advancement of personnel within the field.

The findings as they appear in the tables and narrative analysis refer only to the information summarized from the sample respondents.

INTRODUCTION

The following is an Analytical Response to Section 7007 (c) of the Resource Conservation and Recovery Act of 1976, which mandated that the Administrator of the Environmental Protection Agency authorize such a study. Its format follows the general outline directed by the Act, with the basic content divided under the following topics:

Workforce Profile and Analysis
Obstacles to Employment/Advancement
Training

The Workforce Profile and Analysis section includes an analysis of workforce needs for public agencies (state and local); the private sector; resource recovery facilities and hazardous wastes.

The Obstacles to Employment/Advancement section analyzes what are considered by sources in the field to be the principle blockages to entry and advancement in solid waste management. It reflects on the low esteem of the field in general and the lack of a well-defined career ladder.

The Training section includes an analysis, as defined and intended under the Act, of the U.S. Environmental Protection Agency's responsibilities for workforce development, training activities, and implementation response. It contains summaries of what leading Agency officials believe are the training priorities for proper implementation of the goals of RCRA. Summaries of state and local governmental, universities, and association/private sector training activities and viewpoints are also included.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

WORKFORCE PROFILE AND ANALYSIS

FINDINGS:

Approximately 99 percent of the jobs in the solid waste industry are at the local level in operating agencies and institutions responsible for managing the nation's solid wastes. These agencies utilize a large number of skilled workers including vehicle drivers, a smaller number of unskilled workers, and an even smaller number of supervisory, clerical, and managerial personnel.

Although solid waste management is one of the few remaining large-scale areas for employing unskilled labor, financial pressures on local systems are forcing local governments to effect cost savings in their solid waste systems that can be achieved by decreasing the workforce requirements.

Workforce needs are expected to increase at the state/local levels, in part due to the impending requirements for developing resource recovery and management programs. If resource recovery programs become implemented on a wide scale, growth rate at the operator level may be high. This will also require personnel who are capable of conceiving, designing, constructing, and managing automated systems based on developed technology.

A wide range of skills is being utilized at the state level, including that of geologists, engineers, planners, administrators and clerks, and these workforce needs are expected to increase dramatically with the implementation of RCRA.

Employment needs of the state agencies are currently met by recruitment at colleges and technical schools, and through the state civil service system.

There is a need for chemical engineers and environmental health technicians to handle hazardous and toxic wastes (planning, technical aid and enforcement).

There will be an increase in the number of jobs developed in waste disposal as the nation moves toward environmentally acceptable disposal practices. The personnel most needed for operation of final disposal facilities are operators; however, specifically trained personnel will be necessary to select, design, and manage these ultimate disposal sites.

Job opportunities where expansion is expected include the areas of hazardous waste management; solid waste by-product management from municipal, agricultural, mining and energy operations; and resource recovery and utilization. In the future, as natural resources are depleted, increased emphasis will be focused on regeneration technologies in the solid waste management field. Lack of incentives at the present time still hampers movement in this direction.

In the area of private sector resource recovery, management jobs are more prevalent. There is currently a shift in emphasis to technological services, which require training in engineering, supervisory skills and project planning and management. Shortages in these areas appear to be linked to salaries. Job opportunities in the future will include skilled labor, such as program and plant managers, environmental engineers and technical and supervisory positions, as well as mechanics, equipment operators and electrical and mechanical technicians.

Workforce utilization and the costs of staffing are the major determinants of total costs associated with the operation of solid waste systems. Increased costs for upgrading the nation's solid waste practices will result from the increased workforce that will be necessary to provide safe and environmentally acceptable solid waste management.

RECOMMENDATIONS:

Standards should be set at federal, state, and local levels to implement Acts and regulations effectively. Citizen groups and organizations should be encouraged to sponsor workshops and training sessions in order to help solve solid waste management problems. Establishment of information referrals and clearing houses at federal, state, and local levels could be useful.

A special study is needed to ascertain the impacts of pay and other incentives in the career ladders of labor and management. Financial pressures, workforce turnover and bonus incentives should be studied very carefully before any fundamental changes are introduced in the workforce of solid waste management systems.

Standard certification programs in all technical operations should be encouraged. Seminars, workshops, and short training courses are very suitable for upgrading employees' qualifications and for improving safety records.

Attempts should be made for collaborative efforts on the part of vocational educational programs and institutions; local, state and federal agencies; and industry to improve the quality of the workforce.

Costs of solid waste management can be offset largely through savings achieved by improved workforce practices. Such savings can, in fact, be quite substantial. For example, there is a clear trend toward smaller crews on collection trucks.

OBSTACLES TO EMPLOYMENT/ADVANCEMENT

FINDINGS:

The fields of solid waste management and resource recovery face considerable obstacles both in attracting workers and providing the incentives to them to maintain continued participation in their careers in the public sector.

The image the general public has of the solid waste management field is one of an unattractive work environment and with a social stigma attached to anyone working with garbage. The few qualified persons entering the job market in this field look to private industry which provides higher pay than the public sector can offer.

Because solid waste management is a relatively small field at present, there is little public conception of waste management and resource recovery providing a viable job market. . As a result, prospective employees have little confidence in entering a field which does not have a firm identity as a means of stable employment.

The general nature of solid waste management at the local level seems to result in considerable 'small-town nepotism' of sorts, stifling the emergence of a corps of professional expertise. Often, no consideration is given to the individual's qualifications or capabilities in fulfilling the requirements of the position.

State civil service systems are hampered by disadvantages not faced by private industry. The former find themselves hamstrung by their own regulations under which their professional personnel cannot advance rapidly enough. States have a difficult time competing with the private sector in attracting competent personnel because of salaries and advancement are rather inflexible under civil service regulations. A sufficient number and variety of job descriptions have yet to be devised that provide the in-house mobility necessary for advancement. The current state of the art is such that relatively few positions fulfill managerial functions, while the unskilled bottom-end of the ladder shows a disproportionate number in its ranks. Solid waste management is a classic case of a "few jobs at the top" with "thousands at the bottom."

Solid waste collection is a hazardous occupation; collection workers suffer injuries at four times the rate for all other industry.

RECOMMENDATIONS:

Improvement in the effectiveness of solid waste management processes and greater public awareness of this would result in a greater acceptance of the industry, both as being vital to the general welfare, and as a socially significant industry. This could be partially accomplished by better demonstration of a career ladder, which shows the feasibility of being successful in the solid waste field. In the past, a career ladder concept has not been a significant managerial tool in solid waste management, primarily due to the difficulties in devising an effective ladder within the industry.

In the course of the growth of solid waste management as both a science and an industry, a more detailed pattern of specialized functional areas will evolve. The semblance of such a progression in the eyes of the technicians will provide an incentive to make career commitments. For this to occur, however, improved salary scales and delineated job growtn must be assured.

A fair standard of hiring and promotion must be employed. To ensure the upgrading of the unskilled workers involved in the collection and transport of wastes, either on-the-job training or release time study courses should be developed to provide a built-in system of progression up the job ladder.

TRAINING

FINDINGS

Shortages of well-trained and experienced personnel can delay compliance efforts under the Act. This delay could cause unnecessary confusion and inefficiency and increase the costs of achieving compliance.

If the states are to eliminate incorrect land disposal practices, control hazardous wastes, and develop a long-term program in resource recovery, their staffs will need guidance and training in order to be able to pass on their knowledge to local governments.

State staff could utilize training in the areas of: state and local laws and regulations pertinent to contracting for resource recovery services or facilities; identification of the available or potential markets for recovered materials; and, the conduct of feasibility studies.

At the local level, training is usually on-the-job. Formal on-the-job training usually involves performing specific tasks, e.g., operation of heavy equipment, safety training, etc.

Industry efforts have included assisting state and local governments develop specific skills in managing wastes or in developing state solid waste management plans. This trend is accelerating as there appears to be an increase in the efforts of associations and private groups to provide training in this field.

Currently, there are few solid waste training programs with specific curricula which lead to a degree in solid waste management. Most of the specific training courses are offered by university engineering extension services or adult and continuing education programs. At the university undergraduate and graduate levels, most environmental engineering or environmental science/studies programs offer one or two courses in solid waste management.

The Resource Conservation and Recovery Act encourages the states to establish and implement hazardous waste regulatory programs. Their training needs encompass the following areas: planning, technical assistance (including the training of local and industrial personnel), public participation, technical information and delivery, issuing permits for facilities, the monitoring and surveillance of facilities, and the preparation of litigation for the enforcement of solid waste management regulations.

Inspectors may need extensive re-training in order to become knowledgeable in hazardous wastes management. With the proper training, inspectors should be able to determine whether a material is being handled according to the criteria and standards that will be established. If the materials are not being handled properly, inspectors should be able to call upon other state personnel for technical assistance.

Most resource recovery facilities are designed and operated by the private sector under contract with local and state governments. In the lease agreements there is usually a provision requiring training for operations personnel. These private contractors seem to be able to provide adequate training through a combination of on-the-job and formal training. EPA's Technical Assistance Panels Program can assist in this training by providing technical services and information.

Many states are working through the engineering extension services at state universities to develop short courses and conferences on the subject of resource recovery.

Marketing of recovered resources and waste exchange has proven to be a major stumbling block for many of the resource recovery facilities. Costs of recovered materials are generally greater than costs of those same materials if produced on a large scale by a primary producer.

There is a clear divergence of views between the public sector and the private sector on whether a certification program is needed to ensure proper solid waste management practices. The private sector in solid waste management is generally opposed to the certification of their personnel, while the public sector generally favors it.

RECOMMENDATIONS

All levels of solid waste management personnel, professional, technical, skilled, and unskilled should be trained properly. Continuous on-the-job training programs are needed.

A vital need exists for an on-going training program that would ensure both the day-to-day operations of solid waste management as well as keeping scientists and technicians apprised of new methods and processes. Re-activation of the Environmental Protection Agency's training grants program would address this need in a more detailed form than possible through the on-the-job training currently available. Congress has given EPA the authority to conduct such a program.

As the states prepare Solid Waste Management Plans, it is important that there be a regular and extensive program of workshops and seminars established to assure and facilitate a full and prompt understanding of the requirements that must be addressed in the state plan. In this way, the states can move in a direct and expedient manner toward the development of the most comprehensive and efficient plans. Workshops and seminars have the added benefit of providing increased interaction between federal and state officials.

It is also essential that the skill and competence of sanitary landfill operators be developed if the goals of RCRA are to be met. It is important that an extensive training program be developed so that these personnel will be prepared to implement the regulations properly.

To assure proper implementation of the provisions of RCRA, it is imperative that state and local governments' training efforts be assisted by the federal government.

State enforcement agencies should be encouraged to develop programs to train and/or retrain their personnel in order to keep all personnel current with regulatory developments. This may require courses and/or training programs that are modular in design to be offered under the sponsorship of the states with the assistance of universities, private associations and engineering extension services. The states may require the assistance of the Federal government in order to establish such needed training programs. EPA is currently developing many training programs which could be adopted by the states.

State agencies may have to form technical assistance teams to respond to requests by the waste-generating industries for information on treatment and disposal techniques. These state personnel will need appropriate preparation to be able to provide such services.

State agencies may have to form technical assistance teams to respond to requests by the generating industries for information on treatment and disposal techniques. These state personnel will need appropriate preparation to be able to provide such services.

States must put workforce needs on a priority level equal to their concerns for equipment and legislation. The states must be encouraged to examine their workforce needs from the time of the program's inception so that survey, planning and legislative efforts will result in maximum utility.

State and federal officials need to define what constitutes a hazardous waste and what constitutes safety in the handling of these materials.

A safety program is needed in training personnel in the transport, storage and disposal of hazardous wastes. EPA should utilize those who already have experience in the handling of hazardous substances, e.g., fire departments, police departments, the Department of Defense, etc., and prepare some kind of mechanism through which services could be provided.

EPA could provide financial assistance, to a limited extent, to those educational institutions with specific capabilities of instruction in the collection, transport, storage and disposal of hazardous wastes. These schools may be prime candidates for some training grant involvement and the students attending should receive support only under a payback mechanism.

EPA should develop a series of short courses with a follow-up manual which the participant could take with him/her on the subject of the transport, storage and disposal of hazardous wastes. This could be provided through university extension services, adult and continuing education programs, or on-sight, in conjunction with generators and users of hazardous materials.

EPA might also consider developing a computer data system similar to that already established by the U.S. Army Environmental Hygiene Agency in which methods of disposal of hazardous wastes are stored. This data retrieval system contains information on how specific potentially hazardous materials should be transported, stored and disposed listed by chemical compound. Such a system should be made accessible to all potential users free of charge.

The eventual certification of hazardous waste management handling and disposal personnel should be the goal of the states.

Training within the states should be designed to lead to the eventual certification of the operators. Additional training is also needed for both public and private sector engineering planning personnel to ensure that they have up-dated information regarding the proper selection of sites for land disposal.

WORKFORCE PROFILE AND ANALYSIS

PUBLIC SECTOR

Federal

Federal government activities in solid waste management consist primarily of planning, regulation, enforcement, research and development, and technical and financial assistance. For these activities, the greatest percentage of the workforce requirements are for the professional - a person with a bachelor degree or higher, normally in an engineering, science, or management discipline. The bulk of the solid waste management workforce at the federal level is located within the Environmental Protection Agency, although other federal agencies also have some responsibilities in waste management. Among these are the U.S. Department of Agriculture (agricultural wastes), the U.S. Department of the Interior (mining wastes), the U.S. Department of Energy (energy recovery from wastes), the Department of Defense and the Nuclear Regulatory Commission (hazardous wastes).

Available figures indicate that there were 183 EPA employees in the solid waste management program in 1977, and that this was the same number as employed in 1975, showing no growth.[1] The solid waste management employment was approximately 2% of total agency personnel at that time. Approximately 89% of these employees were engaged in abatement and control activities and the remaining 11% were involved in research and development.

A study by the National Field Research Center [2] showed solid waste management employment in the EPA regional offices in 1977 to be

71 persons. This translates to approximately 39 percent of total EPA solid waste management employment. Annual growth in the regional offices was projected to be at approximately 41 percent to 1981, with the majority of demand being for persons with training in engineering (chemical, civil, sanitary) and the sciences (chemistry, geology). Officials interviewed for this study indicated that the large anticipated staffing increases were needed for compliance with RCRA and assistance to state and local governments to bring them into compliance. After these initial increases, employment is expected to remain constant.

State

According to an EPA Solid Waste Statistical Handbook, published in May, 1978, state government budgets for solid waste management totalled an estimated $28 million in 1977.[3] Today, there are about 1,000 employees in the state solid waste management programs, compared with fewer than 10 in 1965. In general, State managerial personnel are required to have a college degree. In many states, state certification or licensing are required for general management, regulatory, scientific/technical and "other" employees.

In the past, the lack of demand for state level personnel was the result of low priority that states had committed to the solid waste problem. Today, solid waste management still lags behind other environmental pollution control fields, (i.e., air and water) both in funding levels and attention given to solid waste management by the state legislatures.

However, states are becoming increasingly concerned with solid waste management, largely due to: a) the rising costs of solid waste management, b) the impact other environmental actions are having on solid waste management, c) citizen pressures, and d) federal financial assistance provided under Section 7007 of the Resource Conservation and Recovery Act of 1976.

A number of state agencies have determined that the Resource Conservation and Recovery Act will have an impact on the increase of solid waste management jobs in both the public and private sectors. However, the future depends largely upon how many dollars Congress appropriates to implement the Act and the amount of monies that eventually reach each state/locality. The need for positions in the field of solid waste management will undoubtedly grow in the next several years, particularly in the specialized areas of resource recovery, leachate treatment, hazardous wastes, market development and source reduction. Workforce needs will depend greatly upon regulatory requirements.

The problem of estimating the future supply of personnel to perform state level functions is complicated by the fact that workforce needs for quality programs vary significantly from state to state, depending upon how each state defines its missions and role, and divides responsibility between itself and its constituent local jurisdictions. Generally, the smaller the role of each state in solid waste management, the fewer the number of people and lesser the range of skills. Large staff increases are anticipated in the next five years as new legislation is implemented.

At the present time there is a wide range of skills being utilized at the state level including those of engineers, geologists, planners, sanitarians, attorneys, administrators, clerical help, computer specialists, accountants, consultants and technicians. A 1974 estimate of the state workforce in solid waste indicated that approximately 700 persons were employed at that time.[4] The same study indicated that expenditures had risen to $107.6 million,[5] an increase of approximately 33% over two years.

A more conservative estimate of employment growth was indicated in a study of 1976 workforce in state agencies[6] which showed 829 persons employed, an increase of about 18% over the 1974 estimate of 700 persons. A complete breakdown by state and estimates of workforce growth to 1981 are illustrated in Table 1. The projections are based on estimates made by state solid waste officials. Increases presented in the table reflect the anticipated staffing needs to implement RCRA.

TABLE 1

SOLID WASTE - WORKFORCE PROJECTIONS BY STATE 1976 - 1982 (est.)

STATES	1976	1977	1978	1979	1980	1981
ALABAMA	5	5	6	7	8	10
ALASAKA	8	11	14	14	16	16
ARIZONA	2	4	7	8	9	9
ARKANSAS	8	11	13	14	14	14
CALIFORNIA	35	70	76	84	91	98
COLORADO	7	7	11	11	12	13
CONNECTICUT	10	10	15	15	15	15
DELAWARE	9	9	13	15	21	21
FLORIDA	25	N/A	N/A	N/A	N/A	N/A
GEORGIA	36	38	48	56	61	64
HAWAII	2	2	2	3	3	3
IDAHO	9	9	10	12	15	18
ILLINOIS	36	37	38	39	40	41
INDIANA	12	20	30	35	43	50
IOWA	12	13	14	16	17	18
KANSAS	6	6	7	8	9	10
KENTUCKY	33	33	68	83	83	83
LOUISIANA	7	7	12	14	16	16
MAINE	9	9	9	9	9	12
MARYLAND	22	30	36	42	45	48
MASSACHUSETTS	10	10	10	10	10	10
MICHIGAN	11	13	16	19	22	25
MINNESOTA	20	20	20	22	23	24

STATES	1976	1977	1978	1979	1980	1981
MISSISSIPPI	8	12	12	12	12	12
MISSOURI	10	12	14	16	18	20
MONTANA	10	10	10	11	11	11
NEBRASKA	7	9	14	16	17	17
NEVADA	11	13	13	14	15	15
NEW HAMSHIRE	5	5	5	5	5	5
NEW JERSEY	40	56	87	87	87	88
NEW MEXICO	5	5	5	5	8	8
NEW YORK	46	51	51	51	51	51
NORTH CAROLINA	14	22	30	36	38	41
NORTH DAKOTA	3	4	5	8	9	9
OHIO	12	15	24	30	31	31
OKLAHOMA	12	12	16	21	22	22
OREGON	18	25	25	25	25	25
PENNSYLVANIA	72	81	90	99	106	110
RHODE ISLAND	5	6	8	9	9	9
SOUTH CAROLINA	29	33	37	39	39	39
SOUTH DAKOTA	5	6	6	6	7	7
TENNESSEE	20	31	35	35	39	39
TEXAS	66	67	77	120	124	132
UTAH	3	3	4	N/A	N/A	N/A
VERMONT	5	6	7	8	9	10
VIRGINIA	10	10	13	15	18	20
WASHINGTON	25	25	26	28	29	30
WISCONSIN	29	44	55	68	69	71
WYOMING	2	N/A	N/A	N/A	N/A	N/A
WEST VIRGINIA	8	8	8	9	11	11
D.C.	N/A	N/A	N/A	N/A	N/A	N/A
PUERTO RICO	15	18	29	36	36	36
VIRGIN ISLANDS	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	829	990	1,208	1,376	1,458	1,518

Source: National Field Research Center. *A National Environmental/Energy Workforce Assessment*, 1977.

Table 2 illustrates estimates of statewide workforce requirements to 1982 by occupation. Information concerning workforce projections was obtained through on-site and telephone interviews conducted by the National Field Research Center in its National Environmental/Energy Workforce Assessment Phase I study. It was not possible to obtain workforce projections for all states in each of the five categories.

The projected state solid waste workforce is divided into five occupational categories including: engineers, scientists, sanitarians, geologists, and "other". Generally, after a large initial increase in each category the staffing levels are expected to stabilize and show only a small annual increase.

The largest category is composed of engineers, possessing degrees primarily in chemical, civil, mechanical, and environmental engineering. Growth in the engineering staff positions is based on the fact the engineers will be expected to develop systems for hazardous waste management and resource recovery capabilities.

The next category included personnel classified as scientists such as chemists, biologists, soil scientists and hydrologists. The increase in the number of scientists over the next five years is based on the assumption that RCRA efforts will necessitate in-depth research and planning activities. The qualifications require a bachelor's degree in a physical or natural science or engineering.

The attempt to comply with the provisions of RCRA will result in the need for additional personnel in the positions of sanitarian and geologist. These employees will be needed to conduct field studies and surveys, research and analyze scientific data, and help draft new state rules and regulations.

The "other" category includes a wide variety of positions. These include personnel in clerical, administrative, finance, marketing, research, laboratory, law and public relations positions. An increase in staffing is expected to occur in most of these areas over the next five years.

The following table provides solid waste workforce projections by position title:

TABLE 2

STATE SOLID WASTE WORKFORCE PROJECTION STUDY

(1976 - 1981)

POSITION	1976	1977	1978	1979	1980	1981
ENGINEERS	132	169	231	271	295	307
SCIENTISTS	142	161	187	204	212	219
SANITARIANS	70	85	107	126	139	148
GEOLOGISTS	20	30	37	45	47	47
OTHER	134	180	202	216	229	235
	498	625	764	862	922	956

Source: National Field Research Center. A National Environmental/ Energy Workforce Assessment, 1977.

Local

According to an EPA Solid Waste Statistical Handbook, published in August, 1978, about 227,000 people are employed in the management of municipal solid wastes, of which three-quarters are needed for collection of the wastes.[7] Slightly over half of the workforce is employed by private contractors, the rest by municipal and county agencies. Direct costs of municipal solid waste collection and disposal were estimated to be $30 per ton, or over $4 billion a year in 1976. Collection costs accounted for around three-quarters of this, but in many urban areas disposal costs are also high because nearby disposal sites are being filled to capacity, new sites are difficult to establish, and expensive long hauls to distant sites are common. It is expected that the upgrading of land disposal practices to a level that is environmentally acceptable will add considerably to disposal costs for many communities.

Solid waste collection is a hazardous occupation; collection workers suffer injuries at four times the rate for all industries. Individual agencies report injury costs in excess of $1,000 per person-year.

Municipal solid waste is disposed of on 18,500 sites covering a total of 500,000 acres, according to the 1976 Environmental Protection Agency report to Congress on the effects of waste disposal on ground water.

At the local level, the majority of people work in the skilled and unskilled categories (collection and disposal of wastes), as opposed to working in support activities. The managerial and technical type jobs comprise only a small percentage of the local operating workforce.

In the future, the workforce needed to collect municipal solid wastes will probably decrease, as attempts to improve efficiency result in smaller crew sizes and a decrease in the total number of crews. However, as states begin to legislate environmentally acceptable disposal practices, the demand for individuals to operate disposal sites will increase. As a result, there will be an increase in demand for heavy equipment operators for sanitary landfills and technicians for incinerators. Increases in demand in this area, however, will depend largely upon the effectiveness of each state in enforcing its standards.

It is doubtful that anticipated increases in workforce demand in the disposal area will equal the reduction in workforce demand in the collection function. Also, as the need for unskilled workers reduces in an industry, there is a related increase in demand for more highly skilled people to operate new systems and equipment. This is currently happening in the solid waste field, but not to any large degree.

Workforce growth needs are also expected to occur at the local level, in part due to the impending requirements for developing resource recovery and management programs. Input from local sources suggests that the amount of effort spent by local programs for solid waste management may at least double during the next several years of planning. Subsequent growth rates will be contingent upon the types of plans that are proposed, and upon the impact of RCRA at the local level. Indications are that workforces will continue to increase, again being contingent upon the availability of funds.

If resource recovery programs become implemented on a wide scale, the growth rate at the operations level may be high, causing needs for operators with higher skills, for trained technicians, and for highly skilled engineers. For the disposal of hazardous wastes, requirements will probably occur for trained technicians, for scientists, and for engineers. Again, the total workforce impact will become increasingly apparent as state and local plans are finalized, and as federal regulations are released.

A breakdown of local government employment in solid waste management for 1972 was provided in a study by Applied Management Sciences.[8] Table 3 shows the breakdown by type of occupation and percentage of total solid waste management employment.

TABLE 3

Employment and Distribution of Local Government Solid Waste Management Personnel in 1972

OCCUPATION	NUMBER OF EMPLOYEES	PERCENTAGE
MANAGERIAL, TECHNICAL, PROFESSIONAL	2,700	2.6
CLERICAL, SECRETARIAL	2,300	2.3
SUPERVISORY, FOREMEN	6,300	6.2
SKILLED LABORERS	36,200	35.6
UNSKILLED LABORERS	54,300	53.3
TOTAL	101,800	100.0

Source: Applied Management Sciences, Inc. Solid Waste Manpower: Profile and Analysis, January, 1973.

Census Bureau figures from 1974 show a total local employment of 123,207, an increase of 21% over two years.[9] More recent figures indicate a decrease in the rate of growth. The Census Bureau estimated total employment in 1976 at 127,000 and in 1977 at 133,000.[10] Of the 1977 figure, 86% of the local employment was in municipalities, 8% in counties, 5% in townships, and 1% in special districts. The 1976 and 1977 figures show a growth rate of 5% in total employment. Assuming that a 5% annual growth will remain constant, the following depicts local workforce projections to 1985 by type of occupation.

TABLE 4

Projections of Local Government Workforce Growth in Solid Waste Management

OCCUPATION	1972	1974	1976	1977
MANAGERIAL, TECHNICAL, PROFESSIONAL	2,700	3,293	3,392	3,562
CLERICAL, SECRETARIAL	2,300	2,776	2,859	3,002
SUPERVISORY, FOREMEN	6,300	7,601	7,829	8,220
SKILLED WORKERS	36,200	43,825	45,140	47,397
UNSKILLED WORKERS	54,300	65,712	67,683	71,067
TOTAL	101,800	123,207	127,000	133,000

OCCUPATION	1979	1981	1983	1985
MANAGERIAL, TECHNICAL, PROFESSIONAL	3,927	4,329	4,772	5,262
CLERICAL, SECRETARIAL	3,310	3,649	4,023	4,435
SUPERVISORY, FOREMEN	9,063	9,992	11,017	12,146
SKILLED WORKERS	52,255	57,611	53,517	70,028
UNSKILLED WORKERS	78,351	86,382	95,236	104,997
TOTAL	146,632	161,661	178,231	196,499

PRIVATE SECTOR

Historically, management of solid wastes has been shared at the local level by private enterprise and municipal governments. Often, private enterprise acts under contract to the producers of solid wastes in industry, agriculture, and mining. The private sector handles almost all of the nation's commercial and industrial wastes, while the public sector's major responsibility is managing the country's residential wastes.

However, municipal refuse is not always collected by city employees. In many cases, the arguments for private ownership are compelling. For example, many cities' sanitation departments are unionized, and often have so many public-employee members as to have considerable influence on the mayors and city councils. In large cities, the union may exert influence on their department's overall effectiveness and efficiency. In such cases the number of employees is likely to be higher, and their productivity lower. One official of a private refuse-to-energy operation estimated his total staffing to be 60 percent of that of a comparable publicly run plant. A survey by the American Public Works Association concluded that the costs for contracting out refuse collection are 30 percent less than the costs for a city to do the same job.

In some municipalities the spoils system is still apparent. In such cases, where the city owns and operates the plant, who runs the plant may be determined as much by how the individual voted, as by his/her skills, willingness to work, and intellect.

Also, if a city goes into the recycling business, local scrap dealers may be put out of business. The Environmental Protection Agency and other government funding sources of recycling plants often contribute to this dilemma. Scrap companies may not be glamorous, but they perform a useful service and pay taxes, Private enterprise may be better equipped to do the city's recycling than the city itself. Finally, if the financial and regulatory aspects are made attractive enough for private enterprise, the refuse problem will tend to take care of itself because potential profits will attract new business ventures.

According to a study conducted by Applied Management Sciences, Inc., in 1972[11]: 1) in the private sector there is a higher ratio of skilled workers to unskilled; 2) the public sector tends to be more "job support" oriented than unskilled than the private sector; 3) in almost all job categories, private sector employees have a higher mean gross weekly salary than their public sector counterparts; and 4) private firms provide most of the research and development expertise required by federal and state regulatory agencies in developing policies and standards for pollution control.

Also, the private sector has easier access to needed workforce through the labor market than do state and local government employers. However, private sector employers are limited by the pool of available talent in the labor force and by its geographic location.

Finally, industry should take responsibility for managing the private sector's pollution control program. Industry should encourage students to participate in new or current environmental training programs.

The 1972 study of solid waste management personnel cited earlier surveyed 11,000 private contractors doing collection and disposal of solid waste to determine total employment and the occupational distribution of workers. Table 5 presents those data.

TABLE 5

Distribution of Solid Waste Management Personnel in the Private Sector, 1972

JOB CATEGORIES	NUMBER EMPLOYED	
Managerial		17,113
General	16,856	
Other	257	
Clerical		8,619
Supervisory		5,177
Collection/transportation	4,323	
Disposal/other	854	
Skilled Laborers		63,591
Maintenance	6,788	
Collection/transportation	52,873	
Disposal/other	3,930	
Unskilled Laborers		30,402
Collection/transportation	28,385	
Disposal/other	2,017	
Total		124,902

Source: Applied Management Sciences,Inc. Solid Waste Management Manpower: Profile and Analysis, January, 1973.

A 1977 report by the National Academy of Sciences projected the above figures to 1974 basing these projections on a growth rate in the private sector similar to that in the public sector.[12] This translates to a growth rate of 21 percent over two years. Since it may be unrealistic to expect this growth rate in employment to continue once RCRA is implemented, another basis for projecting growth was needed. The Council on Environmental Quality has estimated that private sector expenditures in solid waste operations and maintenance activities will increase at a rate of approximately four percent per year through 1986.[13] This should present a reasonably accurate picture of employment growth since the operations and maintenance activities are labor-intensive. Using the 1974 estimates and projecting employment growth at an annual rate of four percent to 1986, the numbers of personnel required are shown in Table 6.

TABLE 6

Projected Private Sector Workforce Requirements in Solid Waste Management to 1986

	1974	1976	1978	1980	1982	1984	1986
Managerial	20,632	22,307	24,127	26,096	28,226	30,529	33,020
Clerical	10,392	11,239	12,157	13,149	14,222	15,383	16,638
Supervisory	6,241	6,751	7,302	7,898	8,543	9,240	9,994
Skilled Laborers	76,667	81,923	88,608	95,838	103,658	112,116	121,264
Unskilled Laborers	36,654	39,645	42,880	46,379	50,163	54,257	58,684
TOTAL	150,586	161,865	175,074	189,360	204,811	211,523	239,598

Private Sector - Disposal Workforce Projections 1976-1981

As more stringent enforcement of solid waste collection and disposal regulations occurs in conjunction with increased volume of solid waste generated, the private sector workforce is expected to increase.

The following table estimates workforce growth in the disposal area, for the States of Mississippi, Washington, Nevada, Minnesota, and Idaho. As the table shows, the private sector workforce engaged in disposal activities is expected to increase over the next five years. These figures were obtained through personal interviews with solid waste officials in 1976 as part of the National Environmental/Energy Workforce Assessment, Phase I.

TABLE 7

Private Sector - Disposal Workforce Projections 1976 - 1981

STATE	1976	1977	1978	1979	1980	1981
Mississippi	134	142	150	148	166	174
Washington	160	187	209	221	228	245
Nevada	48	52	55	60	65	78
Minnesota	281	281	281	281	281	281
Idaho	88	110	130	140	145	150
	711	772	825	860	885	928

Source:
National Field Research Center. A National Environmental/Energy Workforce Assessment, 1977.

HAZARDOUS WASTES

The disposition of hazardous wastes, while certainly the most serious (indeed deadly) form of disposal confronting the country, is also, unfortunately, the least understood or controlled area of disposal operations. Generally the term refers to wastes which pose a significant or future threat to human, animal or plant life, and may be either chemical or biological in substance and flammable or explosive in nature.

So new is the recognition of this as an area warranting special concern, that it is only within the last four years that close consideration has been given to the hazardous effects of waste disposal to human and environmental well-being.

The Environmental Protection Agency now has on file over 400 case studies of damages - acute or chronic injuries to health, environmental pollution, and economic losses - resulting from improper hazardous waste management. It is clear from the haphazard way in which most of these incidents have come to light that the majority of such incidents have occurred through six major routes: groundwater contamination via leachate; surface water contamination via runoff; air pollution via open burning, evaporation, sublimation, and wind erosion; poisoning via direct contact; poisoning via the food chain; and, fire and explosions.

Of the damage incidents related to hazardous waste disposal that have been documented by EPA, the majority relate to groundwater contamination. An EPA study to investigate the presence of groundwater contamination resulting from subsurface migration of hazardous constituents of land-disposed industrial wastes was completed in 1977.[14] Of the 50 sites sampled, 43 showed migration of heavy metals and/or organic chemicals into groundwater.

It is estimated that up to 90 percent of industrial hazardous waste is being disposed of by the same methods that have produced the damages documented to date. There can be no doubt that controls such as those required by RCRA are needed to assure that generators, transporters, disposers, and others involved in the management of hazardous wastes take the precautions necessary to protect public health and the environment. With general agreement that a distinct danger exists, an effective response is needed.

The complex aspects of the problem and the diverse approach demanded in its resolution require considerable planning and coordination in formulating such a plan. The salient areas in which such assistance is required include:

(1) identification of specific problem areas
(2) research and general education in methods and procedures
(3) management planning, and,
(4) actual disposal operations.

In short, a basic and specific needs assessment must be undertaken as a preliminary step in formulating a comprehensive method of waste disposal. Beyond the general definition given at the outset of this report, definitive parameters of either the problem or feasible solutions have yet to be delineated by the Environmental Protection Agency. Limits must be set as to "acceptable" degrees of hazard or pollution. Feasibility as to expertise, workforce capabilities and cost estimates must be determined.

RCRA Provisions

Subtitle C of RCRA mandates establishment of a regulatory control program which will prevent serious threat to human health and the environment from current practices in managing hazardous wastes. Key provisions are for development of criteria for determining which wastes are hazardous, institution of a manifest system to track wastes from point of generation to point of disposal, and organization of a permit system, based on standards, for hazardous waste treatment, storage, and disposal facilities. Under such controls, each generator will determine whether his/her waste is hazardous according to the official criteria. If it is, he/she must either obtain a permit to manage it on-site or ship it to permitted treatment, storage, and disposal operations which must meet minimum standards developed.

The standards and regulations lay the framework for a federal system to control hazardous wastes. Congress was clear in its intent, however, that the states implement this system as part of their comprehensive solid waste management programs. Section 3006 directs EPA to develop guidelines by which such authority will be granted. EPA must grant authorization to interested states unless it finds that the proposed state program is not equivalent to and consistent with the federal program. Federal grants to states are authorized for fiscal years 1978 and 1979 to aid the establishment of acceptable hazardous waste programs. In any state that decides not to establish a hazardous waste program meeting federal standards, EPA will administer regulatory control.

To be effective, equitable, and practicable, standards and regulations must be firmly based on an extensive data base which can be used to analyze the regulatory alternatives and to support the chosen approach. Similarly, the quality of technical assistance depends on the reliability of the technical and economic data base. Under authority of Subtitle H, the Office of Research and Development and the Office of Solid Waste have continuing programs to develop this data base.

For the hazardous waste management program to be fully implemented, enough permitted facilities for treatment, storage, and disposal must be available to manage the wastes generated. Although the existing service industry typically operates at only 50 percent of capacity, the current total capacity is still far short of projected needs. The need to facilitate and to avoid discouraging capacity creation has been taken into consideration by EPA in the development of regulations and guidelines, and provisions of technical assistance.

Program Management

Without discounting the importance of such logistical aspects of management as funding and technique, perhaps the most crucial factor in an area with as much "unchartered territory" as hazardous waste management is personnel. Directions taken in the areas of funding, research, and policy have to be established and executed by people who possess a scientific base, foresight as to ramifications of their work beyond their immediate operations, and a realistic approach that is guided by scientific data. Furthermore, due consideration must be paid to constraints imposed by funding and staffing limitations, especially in the incipient stages of such a program.

Workforce Requirements

Only a limited amount of information is available concerning employment in the hazardous waste field. A 1976 study done for EPA estimated that approximately 2,000 people were employed in hazardous waste management in 1975.[15] Of this number, 11 percent were estimated to be professionals, primarily chemists or chemical engineers. The following figures indicate the distribution of hazardous waste employees in 1975.

TABLE 8

Estimated Employment in the Hazardous Waste Management Industry in 1975

Employees	Numbers	Percents
Professional	185-275	11.0%
Skilled	935-1,085	49.5%
Unskilled	760-860	39.5%
TOTAL	1,940-2,140	100.0%

Source:

U.S. Environmental Protection Agency. Potential for Capacity Creation in the Hazardous Waste Management Industry, August, 1976.

Projections of future workforce requirements were not obtainable from available data.

Determination of the future workforce required in hazardous waste management will largely be contingent upon the type of management program that is developed by the states. As the field appears to be destined toward rapid expansion, it appears that needs will substantially increase for professionals with expertise in the field.

Finally, an increase in the collection, transportation, storage, and disposal of hazardous wastes will result in a greater need for a cadre of trained technicians responsible for ensuring the integrity of hazardous waste processing. As most of these wastes are generated in the private sector, workforce growth will be located primarily in industry and be substantial. The growth potential will be pursuant to the establishment of comprehensive statewide hazardous waste management regulations for industrial waste generators.

RESOURCE RECOVERY

It is encouraging to note the many positive vital signs of resource recovery progress. Yet the reasons for moving to recovery as a waste disposal alternative are essentially local in nature. In spite of the national dialogue about conservation of resources and preserving the environment, little incentive is currently being offered by the Federal government to stimulate resource recovery implementation.

It is puzzling, for example, that with so much being said about pursuing new sources of energy - solar, geothermal, wind, etc.- that relatively little interest has been expressed by the federal government in tapping the energy potential from solid waste. This is evident from the rather small amounts of monies allocated for the support of resource recovery projects.

Despite the perceived promise of the Resource Conservation and Recovery Act to promote the reclamation of valuable materials from residuals, only minor efforts, resources and priority ranking are evident in this important area.

Under RCRA, the states are given increased and substantial responsibilities. It is hoped that in the press to carry out the regulatory aspects of land disposal and hazardous wastes control, resource recovery considerations will not be lost in the shuffle. In a real sense, resource recovery should play an integral part in the planning picture. To achieve the objectives of 1) environmentally sound disposal, 2) stabilization of costs, and 3) conservation of resources, resource recovery has the potential for utilization by a growing number of jurisdictions.

Resource recovery is still a relatively new field which utilizes highly technical systems and requires large amounts of both time and money before operations are begun. It can take over five years to study, plan and construct a facility at a cost of millions of dollars.

The development of resource recovery has not been without its setbacks and problems but these have been offset by the gains. The result has been a slow, gradual development in both the technical and non-technical (planning, procurement, market studies, etc. . .) aspects of resource recovery. Both the problems and advantages of recovery systems have greatly added to our knowledge of resource recovery. This expanding base of knowledge has increased the confidence with which a community will approach recovery as an alternative to traditional landfilling.

The increasing availability and amount of information from test prototypes and operating systems is one reason communities are investigating resource recovery. In addition to this, there are the difficulties and increasing costs associated with landfilling, the present and projected problems of obtaining natural gas, coal or other fuels , and the national emphasis being placed on conservation and recovery of our natural resources.

There is still much to be learned in all areas of resource recovery. As more plants are built and put into operation and as more testing is accomplished, our knowledge in the field will increase.

It is hard to say how long it will take until resource recovery is no longer considered a new and rather risky endeavor.

The gradual gains, so far, seem to indicate that it will take at least a few years for even the most prevalent of today's processes to reach this stage. For now, it appears that one may be optimistic about future gains but only with the realization that they will take time. Until then there will be a great deal of caution involved when a municipality looks at resource recovery as an alternative solution to its present solid waste management problems.

The design, implementation, and operation of a resource recovery system are based on personnel distribution into four basic functional areas:

--managers, possessing both technical expertise and supervisory abilities;

--sorters, whose skills are experientially based (on-the-job training), rather than derived from formal education;

--material handlers and processors, who possess machinery and equipment operating skills; and,

--unskilled laborers, who perform the collection and transport tasks for materials handling operations.

Currently the heaviest concentration of workers is in the collection, transportation, and sorting processes. However, with increasing mechanization of material processing, reliance on manual labor will diminish with the double-edged effect of improving labor productivity while eliminating opportunities among unskilled labor forces.

Part of this workforce cut is being offset as technological advances are made. Engineers, research scientists, and other specialists are entering the field, resulting in the development of increasingly sophisticated methods of resource recovery.

Efforts in the field of resource recovery, while only a fraction of the efforts in the management of solid wastes, have yielded an estimated 50 million tons annually of matter that would otherwise have been discarded. Similar to solid waste management in one regard, resource recovery is labor intensive in that the collection of the secondary materials is labor-consuming in nature.

The Saugus, Massachusetts Plant: A Private Operation

The Saugus, Massachusetts plant, the nation's first full-scale, privately financed refuse-to-energy plant, was built with private money and through private initiative. Many believe that in order for the resource recovery industry to get the needed plants on-line, it must be prepared to assume overall responsibility for the capital, technical and operational aspects of these plants. The Saugus plant proves that private industry can offer important advantages to the cities these plants serve. Some of those advantages are:

1. Private financing will conserve limited municipal capital resources.
2. Private responsibility will free most cities from the need to acquire the technical and operating background necessary to manage the system.
3. Private industry is able to offer cities full long-term service agreements free of the liabilities of owning and operating disposal systems by requiring payment only for services rendered.
4. Private financing costs can be competitive with government financing through the use of tax-exempt pollution control revenue bonds.

5. Private industry is also able to take advantage of other tax credits and allowances not available to government entities, and thereby further offset financing costs.

6. Most significant of these advantages is that resource recovery plants such as Saugus are property tax paying additions to the communities; not only local property tax, but also state and federal taxes as well. For example, the Saugus plant will be paying a million dollars a year in property taxes alone.

7. Finally, with proven reliable technology, the communities can be assured of their solid wastes being disposed of in a dependable, environmentally acceptable way.

An occupational profile of the Saugus plant is illustrated in Table 9. Each position has been structured to afford the utmost in operating effectiveness and economy. The qualifications of the plant personnel are based on extensive experience in addition to meeting accepted professional standards. While workforce needs and job descriptions vary from plant to plant, the Saugus workforce summary gives an indication of the type of positions and requirements that many resource recovery facilities utilize.

TABLE 9

WORKFORCE PROFILE
Saugus, Massachusetts Resource Recovery Plant

OPERATIONS:	
Scale Operator	1
Floorman	4
Crane Operator	5
Ash Handling & Metal Operator	4
Traffic Controller	1
Warehouse	1
D.I. Equipment Operator	1
SUBTOTAL	17
BOILER OPERATIONS:	
Watch Supervisor	4
Boiler Operator	4
Assistant Boiler Operator	8
Laborer	5
Labor Foreman	1
Maintenance Foreman	1
Maintenance	9
Turbine	4
SUBTOTAL	36
ADMINISTRATION:	
Plant Manager	1
Comptroller	1
Chief Engineer	1
Plant Engineer	1
Secretary	1
Record Clerk	2
SUBTOTAL	7
TOTAL	60

Source: Saugus, Massachusetts Resource Recovery Plant

TABLE 10

Locations of Major U.S. Resource Recovery Facilities:

Refuse - Derived Fuel

- Ames, Iowa
- Baltimore County, Maryland
- Bridgeport, Connecticut
- Chicago, Illinois
- Lane County, Oregon
- Milwaukee, Wisconsin
- Monroe County, New York

Waterwall Combustion

- Akron, Ohio
- Braintree, Massachusetts
- Chicago, Illinois
- Hempstead, New York
- Nashville, Tennessee
- Niagara Falls, New York
- Norfolk, Virginia (USN)
- Portsmouth, Virginia
- Saugus, Massachusetts

Small Modular Incinerators

- Blytheville, Arkansas
- Crossville, Tennessee
- Groveton, New Hampshire
- North Little Rock, Arkansas
- Siloam Springs, Arkansas

Codisposal

- Duluth, Minnesota
- Franklin, Ohio
- Harrisburg, Pennsylvania

Source: U.S. Environmental Protection Agency. *Solid Waste Facts: A Statistical Handbook*, August, 1978

OBSTACLES TO EMPLOYMENT/ADVANCEMENT

The principal obstacle to employment and advancement in the solid waste management field is the general low esteem in which the field is held in the minds of the public: the traditional outlook of "Who wants to be a garbage man?" Many qualified individuals look to other environmental fields such as water or air pollution control. Thus, state and local regulatory and operating agencies have difficulty in attracting personnel into this field. Another major obstacle is the low budget priority which society places on solid waste management in general.

Local Government

Local government hiring in solid waste management (primarily collection/disposal) is conducted through civil service examinations, e.g., electrician, maintenance mechanic, etc. There will always be enough personnel on hand to handle the unskilled and semi-skilled jobs. New personnel can be trained on-the-job by experienced staff. For example, in street collection a person can progress from a laborer's job behind a truck to a gang leader and then to a supervisor. However, the problem is one of difficulty for local public works departments to recruit skilled people to begin with because the potential for advancement is very limited. Many landfill operators cannot advance into management positions within their departments. It is also difficult to recruit outside personnel with knowledge in the field. One municipality contacted had openings for five supervisors for street collection activities and could not obtain these five internally. This same municipality (Baltimore) offered free job-related schooling for its employees but very few were interested. Thus, image is a serious recruitment problem for local public works departments.

There is an increasing trend in municipalities to get out of the solid waste collection and disposal business and contract these services out to private firms. This trend of letting the private sector manage these services shows that there may be more opportunities for the unskilled worker in the private sector.

Private Sector Involvement

In the private sector it appears that obstacles to employment and advancement in the field are rapidly declining. For instance, a number of solid waste management companies have become large companies that later became international conglomerates. A number of conglomerates have bought out the smaller private firms which did nothing but collection and dumping. Thus it is becoming a big business which continues to grow. The entry into the business of the conglomerates shows that the private sector sees this field as an opportunity to make money.

There is also a great potential for resource recovery in terms of industrial materials trade-offs. A waste material for one firm may be used as a resource by another and this has the potential of taking many toxic and hazardous materials out of the wastestream and into the pool of resources available to manufacturers. It appears that industrial waste exchanges may provide potential employment and occupational advancement in the field.

The private sector has been quite successful in managing solid wastes primarily because it recognizes that the demands of the job are much more than the muscle or the back. Competition exists within the industry for a higher intelligence level in a person because the industry is very heavily committed to hiring and retraining highly qualified drivers and transportation people. The salaries and pay to the workers in private industry are competitive with similar areas in the trucking field.

The solid waste management industry is highly unionized and there generally is an adequate base of talent available to operate the heavy machinery. Landfill supervisors in the private sector do not seem to have had much trouble recruiting qualified operators because the work is steady when compared to the construction industry. Operators are trained by coming up through the ranks of the construction industry and substantial material is available to assist heavy equipment operators to adapt to the specific practices of equipment handling on landfills. Additional training at the job site is generally obtainable from representatives of the equipment manufacturers. Advancement in the field also comes about through sound business practices as there is an on-going professionalization of the field in general.

State operating standards will require a more sophisticated engineering and upgrading procedure for landfill sites to be in compliance. There will be a greater emphasis placed on enforcement of these standards. However, this does not appear to be a factor to change the career advancement opportunities as much as it will require a more intensive management in the cities and companies which own and operate these sites. Thus, there will not be much of an expansion of the employment base.

State Needs

States suffer a recruitment problem in attracting engineers to serve as agency inspectors because of relatively low level starting salaries, especially when compared with private industry. State civil service agencies cannot upgrade these positions for state solid waste management agencies without also doing so for the other state agencies with engineers on their payrolls. Young, competent engineers thus accept jobs in the private sector which pay much higher salaries and can promote engineers much more quickly. State enforcement agencies also often lose their most qualified personnel to the private sector after one to two years. It appears that no civil service system can compete with this because they cannot advance their personnel rapidly enough. States cannot hire personnel with Federal funds because most states have laws prohibiting the hiring of permanent personnel with these funds. States thus contract the work to consulting firms. It is unlikely that many states will be willing to increase their budgets for solid waste management to hire a significantly greater workforce in this field.

TRAINING

PUBLIC SECTOR

FEDERAL

Authorization Under Section 7007 of the Resource Conservation and Recovery Act of 1976

Two levels of training are addressed under Section 7007, Grants or Contracts for Training Projects. The first level concerns the training of instructors; and, the second level addresses the training of persons in occupations involving the management, design, supervision, or maintenance of solid waste disposal and or resource recovery equipment and facilities.[16]

EPA Office of Solid Waste Implementation Approach

EPA headquarters senior staff has determined that the primary focus of the Office of Solid Waste's workforce development and training efforts will be three receptor groups: EPA personnel; state personnel; and participants (contractors and/or grantees) in the Technical Assistance Panels Program.[17]

These three receptor groups will be provided with training of two types of the U.S. Environmental Protection Agency:

a.) Overall orientation on the program, policies, Resource Conservation and Recovery Act provisions, essential regulations and guidelines, issuances and mechanisms to comply with regulations, and the skills needed to deliver technical assistance under the Technical Assistance Panels Program.

b.) Specialized training to allow EPA and state personnel and others, as it seems appropriate, to actually administer a particular function or respond to particular requirements of the Resource Conservation and Recovery Act, i.e., the inventory of open dumps and the issuance of hazardous wastes facility permits.

The overall orientation program's development and management is the responsibility of the Resource Recovery Division. Other divisions provide assistance and support to ensure the technical validity of the various portions of the program. The training officer, working through the Management and Information Staff, provides support to develop and administer the program.

The Resource Recovery Division, Systems Management Division, and the Hazardous Waste Management Division are responsible for the development of the specialized training programs. The Management and Information Staff's role is to assist the divisions in administering the training and to ensure that the program is integrated and coordinated.

The orientation program is to be conducted eventually by the Regional Office staff. The Resource Recovery Division and EPA headquarters will continue to have responsibility for course development, management and coordination.

The Management and Information Staff's Technical Information and Communications Branch has the responsibility of coordinating division activities relative to the implementation of Section 7007. Other than the Report to Congress, which is the subject of this report, implementation of Section 7007 also involves: identification or development of curricula and materials; and delivery of training and materials.[18]

The Office of Solid Waste work-group on training is chaired by the Resource Recovery Division. This committee coordinates efforts to develop courses and materials to be used by the Office of Solid Waste for training personnel in state agencies. One task of the committee is to identify courses and materials already in existence and to identify those areas where no training materials exist. The Office of Solid Waste's training officer and work group have the stated objective of having formal courses and materials ready for use by the states by 1979. They also are to ensure that universities and state technical schools involved in Solid Waste training are aware of the availability of OSW-developed training materials.

The importance of the Federal government in providing guidance for training in solid waste management cannot be overemphasized if the Office of Solid Waste's goals for implementation of the Resource Conservation and Recovery Act are to be met. "At this critical stage in implementation, shortages of well-trained and experienced personnel can delay compliance efforts with the Act at its most crucial point. This can cause unnecessary confusion, inefficiency and boost the cost of achieving compliance."[19]

Current Federal Training

State and local governments receive technical assistance through the Technical Assistance Panels Program, available through the EPA

Regional Offices. The Technical Assistance Panels Program consists of a group of federal, state, and local government employees and contractors. These groups are assembled to assist in solving specific technical problems on-site as they arise. Through a peer-matching concept, officials with expertise in solving specific problems are available to assist their peers in other areas. The peer matching expertise categories are as follows: collection; transfer; processing; incineration; resource recovery; disposal; and, management. The American Public Works Association and five other associations of state and local officials are assisting in this program.

Resource Recovery Implementation Seminars are also being conducted by the Office of Solid Waste headquarters staff. In 1978 this two-day seminar has been held (as of October,1978) in six cities and has been attended by nearly 1,000 persons. The seminars are directed toward the implementation of resource recovery, through both mixed-waste processing and source separation.

The EPA National Training and Operational Technology Center at Cincinnati, Ohio offers two wastewater treatment technology courses concerning sludges. The Resource Conservation and Recovery Act contains a broad definition of solid wastes which includes sludges and liquids as well as solids. The criteria for land disposal of wastes that are not to be considered hazardous have been proposed; approximately 150,000 landfills for municipal solid wastes, sludge disposal sites, pits, ponds and lagoons will be subject to the criteria. The two courses are as follows: (166) Sludge Treatment and Disposal; and, (177) Land Application of Wastes. The Land Application of

Wastes course is "for engineers, scientists, waste management specialists and other practicioners who are concerned with waste disposal alternatives for municipal, industrial and agricultural wastes."[20] The Center serves as the operational focal point for the Office of Water Program Operations by providing training and other assistance for governmental agencies, educational institutions and the private sector. It's primary thrust is for water pollution control and abatement.

EPA's Technology Transfer Program recently held seminars on Sludge Treatment and Disposal. Four seminars were conducted as of October, 1978 and each seminar had approximately 200 or more persons attending. These seminars included a field trip to Los Angeles County Sanitation District's Joint Plant Solids Processing Facility and Pilot Study and the latest design information on new technologies.[21]

The Hazardous Waste Management Division is preparing a Regulation Information Program for Generators and Transporters of Hazardous Wastes. The Project is designed to "provide EPA headquarters and Regional Office Solid Waste personnel with a Regulation Information Program complete with instructional materials to be used in workshops."[22] A significant aspect of this program is the fact that the EPA will adopt the Department of Transportation's Hazardous Waste Materials Transportation Regulations for the promulgation of the hazardous waste transportation regulations. This program will be useful in facilitating the education of users and transporters on compliance with these regulations. The division has also recently awarded a contract to the Fred C. Hart Company for the preparation of a manual to train EPA Regional Office solid waste program personnel on how to evaluate and process hazardous waste permit application forms. They will also prepare an instruction course to teach the procedures. The Hazardous Waste Management Division has other courses in varying stages of preparation.

Training Grants

Solid waste training efforts at the federal level were once much greater than at present. The Office of Solid Waste Management Programs of the EPA and the Bureau of Mines of the U.S. Department of the Interior were the two Federal agencies most involved. The EPA's emphasis was in four main areas: university grants and fellowships; state training grants; direct training; and, safety training. The U.S. Bureau of Mines awarded grants to mining-oriented universities for the training of personnel at both the graduate and undergraduate level in the disposal and recovery of minerals.

According to the EPA Grants Information Control System, a total of 127 grant awards were made for Solid Waste Training. A majority of these (72 or 56%) were awarded to associations and private groups for public participation, citizen education, and assistance to cities, states, and counties. Since 1972, when the first 16 grants were awarded to associations and private groups, the number of awards has increased to 22 grants in 1978. The second largest group consists of universities which received 28 grant awards (23%) since 1968, when the first grant was awarded to the University of Illinois. Most of these grants went to universities which offered a graduate degree in engineering and a major in Solid Waste Management. The program was at its height in 1972-73 when eleven grants were made in each of the two years. Thereafter, the number of training grant awards steadily decreased. EPA was attempting to follow an Office of Management and Budget (OMB) request to phase out academic training grants by FY 1976. However, Congress included in FY 1977 an appropriation of $4 million for academic training in the EPA appropriations bill. According to an EPA memorandum, Discussion of FY 77 Training Grants, "...current EPA policy is that no new academic training grants and fellowships be awarded through FY 1976, and that no awards be made from FY 1977 onward."[23]

Table 11 which follows, depicts the number and percentage of solid waste training grants awarded up to September 14, 1978, according to the Grants Information Control System:

TABLE 11

Solid Waste Training Awards
(as of 9/14/1978)

Calendar Year	University	State/ Local Agencies	Associations/ Private	Calendar Year Total & %
1968	1	0	0	1 - 1%
1971	2	1	0	3 - 2%
1972	11	11	6	28 - 22%
1973	10	5	7	22 - 18%
1974	2	5	4	11 - 9%
1975	1	3	10	14 - 11%
1976	0	2	9	11 - 9%
1977	0	0	14	14 - 11%
1978	1	0	22	23 - 18%
	28-23%	27-21%	72-56%	127

Source: U.S. Environmental Protection Agency.

The table on the preceding page illustrates the fact that during the ten year period 1968 - 1978, more than one-half (56%) of all training grants awarded have been granted to private groups and associations. Specialized training is but one of their many functions in receiving these funds. Universities and state/local agencies have received almost an equal amount of the remaining total of grants (44%).

Rather than disregard the intent of Congress to continue to support academic training programs or not comply with the regulations of OMB to phase out the program, the EPA has proposed working through the more traditional agencies responsible for the development of workforces and training, i.e., Department of Health, Education, and Welfare (DHEW)/Office of Education, and Department of Labor (DOL). "This development and stimulation has taken the form of a "seed money" exercise in which EPA transfers funds to another agency in order to utilize its administrative and programmatic delivery (and matching requirements) system while institutionalizing that particular program within the other agency's constituency, both at the federal and state levels."[24] Through an interagency agreement with HEW's Office of Education, $100,000 would be designated for solid waste academic training grants. These funds would be used for solid waste education and training, and would benefit landfill and hazardous wastes facility managers. Such an approach would improve the management of hazardous wastes, especially those that relate to land disposal practices in order to minimize adverse impacts on ground waste supplies. The EPA Office of Solid Waste would serve as the lead office working through the administrative structure of the U.S. Office of Education by means of an interagency agreement. The primary audience would be selected by state solid waste management agenices.

According to a table developed by EPA for internal review (EPA Funding for Manpower Development and Training Programs), the Office of Solid Waste Management has received minimal funding for training grants, direct training and personnel planning activities. The EPA funding and staffing for manpower development and training programs appears in Table 12.

TABLE 12

EPA Funding and Staff for Manpower
Development and Training Programs
(Thousands of Dollars)

Program Activity	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979
Office of Solid Waste Management Programs						
Training Grants	$365	$202	0	0	0	$100
Direct Training	$ 74	0	0	0	0	0
Manpower Planning	$ 50	0	0	0	0	0
TOTAL	$489	$202	0	0	0	$100

Source: U.S. Environmental Protection Agency

As depicted in the above table, training received no funding in FY 1976, FY 1977, and FY 1978. The total amount of funding designated for training grants for all program areas (air, water, and solid waste) in FY 1979 is $1.5 million. The air and water programs are to receive $700,000 each, while the solid waste program will receive

$100,000. This is a noticeable increase considering the fact that the solid waste program has not received any funding for training grants since FY 1975.

Regional Office Training Activities

The EPA Regional Offices will play the major role of assisting the states with the development of their management plans for the implementation of subtitles C and D or RCRA. The states will be responsible for conducting hazardous waste surveys, open dump inventories, and for developing resource recovery systems. Therefore, training and technical assistance are crucial components of the EPA Regional assistance to the states. Although EPA must develop basic regulatory standards and guidelines for RCRA, state and local governments have the task of implementing and enforcing these standards. The EPA Regional Offices have a responsibility to assist the state and local governments in upgrading their programs through training and technical assistance in order to develop Solid Waste Management Plans and to qualify for interim authorization to operate hazardous waste programs.

Training of federal, state, and local solid waste management personnel was once the responsibility of the Solid Waste Training Academy of EPA's Office of Research and Development. The Solid Waste Training Academy presented packaged courses across the nation in the field of solid waste management. The abolishment of the Academy was due in part to a decreased emphasis at EPA on training. Since the abolishment of the training academy, responsibilities have been shifted to the EPA Regional Offices. Because of budget limitations, most regional training activities have consisted of one-on-one technical assistance to the states. Since the passage of RCRA, most EPA Regional Office solid waste programs have anticipated expansion and strengthening of their training efforts toward the states. Most regional personnel consider specialist/technical training to be vital for the conduct of solid waste management practices and procedures.

Regional Offices assist the states in developing their capacity for preparing and implementing appropriate training programs for landfill operations and collection personnel. Grants have been awarded to states to train for occupations for the management, supervision, design operation and maintenance of solid waste disposal and resource recovery equipment. Grants have also been issued to train instructors and supervisors to conduct training in these areas. Training in the states is especially needed for specialist and enforcement personnel for hazardous materials regulations. Sanitary landfill operators will be in need of training as better disposal operations are developed.

The Atlanta Regional Office established a Southeastern Solid Waste Management Training Committee in 1976 to critique training needs and to provide the needed training. This Committee is composed of state solid waste directors and the staff of the Region IV Solid Waste Management and Land Protection Section. Major objectives of the Committees' activities are to provide improved orientation for new employees of state solid waste management agencies and to increase consistency among the state solid waste management programs in the southeastern states. They held their first course in October of 1976 on "Elements of Solid Waste Management". They recently held a Solid Waste Management Workshop in Mississippi for new employees of the states in Region IV. This Workshop included such topics as: Introduction to Solid Waste Storage and Collection Systems; Equipment Selection and Monitoring; Sanitary Landfill Design and Operation; Transfer Operations, State-of-the-Art on Resource Recovery; a Field Trip to Resource Recovery in New Orleans; Hazardous and Industrial Wastes; Dump Closing and Inventory; Enforcement Procedures; and the State of the RCRA.

Other Regional Offices have also conducted courses and supported the efforts of universities and vocational educational institutions to develop training. Region IV has encouraged Texas A & M University to establish a training center to provide training in solid waste management. Regional VII provided nine total days of course work (5 courses) to 300 state and local employees in 1976. The five courses included: Solid Waste Management; Resource Recovery Seminar (Ames, Iowa Resource Recovery Facility); Solid Waste Management Conference; Solid Waste Management in 208 Planning; and, Solid Waste Collection.

A summary table of regional office solid waste training activities based on data collected shortly after the passage of RCRA in late 1976 is as follows:

TABLE 13

Summary of EPA Regional Office Solid Waste Activities

EPA Regional Office and City	Training for Regional Solid Waste Management Staff			
	Formal	Informal/OJT	Staff Participation in Univ./Assn. Seminars/courses	Training for State/Local Personnel
REGION I - Boston		X		
REGION II - New York		X		
REGION III - Philadelphia		X	X	
REGION IV - Atlanta		X		
REGION V - Chicago			X	X
REGION VI - Dallas		X		
REGION VII - Kansas City		X		X
REGION VIII - Denver		X		
REGION IX - San Francisco	X		X	
REGION X - Seattle		X		
TOTALS	1	8	3	3

Source: National Field Research Center. A National Environmental/Energy Workforce Assessment, 1977.

STATE

State Governmental Training Needs

The principal thrust of the Resource Conservation and Recovery Act (PL 94:580) is that the states are to assume the primary enforcement responsibilities for its implementation. If the states are to eliminate improper land disposal practices, control hazardous wastes from "cradle to grave" and develop a long-term program in resource conservation, their staffs will need guidance and training in order to be able to pass on their knowledge to local government and to industry. Under the Act, the definition of what constitutes a "solid waste" has been greatly expanded from the previous federal Solid Waste Disposal Act to include municipal solid wastes, hazardous wastes, liquid wastes and sludges. Subtitles C and D relate to those provisions in the Act which concern the development of state solid waste management plans. The development of the plans are to be shared jointly by various levels of government. Subtitle D also provides for federal financial assistance to state and local governments for the implementation of these plans. Subtitle C enables state governments to regulate "cradle to grave" handling and disposal of hazardous wastes. It also allows the states to assume the permitting and regulatory responsibilities over the hazardous waste management program but requires the federal government to assume that responsibility if the states fail to act.

Some states often do not have the necessary legislative authority, personnel, or budget capabilities to assume the responsibilities for implementing RCRA. Assistance to the states for planning and implementation of RCRA from the Federal government (which includes funds for inventories) is expected to total $11.2 million in FY 1979. To assure proper implementation of the provisions of RCRA it is imperative that state and local governments' training and workforce needs be assisted by the Federal government.

Mr. Tommie Gibbs of EPA conducted a survey of approximately 20 state and local agencies and seven regional offices in April 1977. In his report, "Solid Waste Management Strategy for Manpower Development/Training", he states that [25]

> There is an immediate need for training, but solid waste training is insufficient and inadequate to meet the present demand. The states feel that EPA should provide financial and technical training materials, curriculum development, and the overall coordination of external delivery systems. This means that EPA will have to take a stronger leadership role in assisting and developing state and local training capabilities. Most well-established state programs are cooperating in the development of self-sufficient training programs and are willing to open their doors to other state and local programs. It would be cost-effective to develop the delivery systems for training already in the hands of state and local officials and to use these agencies for delivering solid waste training. The states will need the leadership and the tools to meet the demand. By providing new training material for hazardous waste management and resource recovery, the OSW could provide the technical assistance needed to conduct such training. Whether or not states receive the necessary training grants and program grants will determine the state's self-sufficiency in training within the next five years.
>
> The overall interest and response shown in this survey was so great it is believed that the decision to develop and implement a manpower training effort at the federal level is warranted at this time.

Section 7007 of the Act, Grants or Contracts for Training Projects, authorizes the Administrator of EPA "to make grants to and contracts with, any eligible organization." These grants are to be designed:

> "(A) to develop, expand, or carry out a program (which may combine training, education, and employment) for training persons for occupations involving the management, supervision, design, operation, or maintenance of solid waste disposal and resources recovery equipment and facilities; or,
>
> "(B) to train instructors and supervisory personnel to train or supervise persons in occupations involving the design, operation, and maintenance of solid waste disposal and resource recovery equipment and facilities.

It is clear that there is legislative authority for the EPA to support state solid waste training programs. According to EPA's Guidelines for Development and Implementation of State Solid Waste Management Plans, which was published in the August 28, 1978 issue of the Federal Register,[26] "Guidelines for Development and Implementation of State Solid Waste Management Plans":

> "The State Plan will also result in activities to encourage resource conservation and resource recovery. This will include activities to eliminate institutional barriers to recovery facilities (such as prohibitions to long-term contracts for supplying wastes); activities to develop markets for recovered materials (such as state procurement of products composed of such materials); and other technical assistance, training, information development, and financial assistance activities. Such activities require State, substate, and private sector involvement."

EPA's Office of Solid Waste (OSW) prepared a "Manpower Development Policy Paper" (Draft, March 13, 1978) which focused on "developing a policy for the solid waste management development programs supported (directly or indirectly) by the OSW."[27] In the conclusion were the following suggestions:

> "This policy paper suggests that we target our rather limited manpower development resources at three sectors of the solid waste management movement - EPA personnel, State personnel, and 2003 Program Consultants (Technical Assistance Panels or Resource Recovery and Conservation Panels). The policy also suggests that the training focus on those skills needed by the three sectors to implement the land disposal regulatory, the hazardous waste control, and the resource conservation programs required of State governments by Subtitles C and D of RCRA. Finally, the policy suggests that in the outset, the training programs should be developed by OSW and delivered from all portions but under the management of the 2003 Program in RRD (Resource Recovery Division)."

According to the Council of State Government's 1973 report on "The State's Role in Solid Waste Management: A Task Force Report," the function of state government in solid waste management is:

> "State governments have the obligation of assuring that local governments provide for efficient, environmentally sound solid waste services for their inhabitants. The States cannot be satisfied with only a regulatory role; they must provide various forms of aid (administrative, managerial, financial, and technical) necessary to assist and encourage local governments to expand and improve services."

Applied Management Services, Inc., conducted a 1973 study, "Manpower Profile and Analysis" in response to Section 210 of the Solid Waste Disposal Act as amended, for the EPA's Office of Solid Waste Management Programs. This study found that: [29]

1. "Little formal training exists at the State level."
2. "Virtually the only people hired at the State level with prior solid waste experience are public health administrators."
3. "Formal training for skills applicable to solid waste management is not widely practiced."
4. "...most of the training comes from being on the job and applying skills to a new subject area."

5. "Only 20 percent of persons in these categories actually receive formal training, given largely by specialists in the area of private firms on a contract basis."

The conclusions of Applied Management Services, Inc., concerning state training deficiencies in 1973 are supported by the conclusions of Mr. Tommie Gibbs of EPA in his 1977 study; "Solid Waste Management Strategy for Manpower Development/Training" (April, 1977).[30] In his Summary of Findings, Conclusions and Recommendations Resulting from the Project Assignment, he states that:

> "There is no large-scale shortage of solid waste manpower, but it is possible that without proper training certain selected, specialized occupations may experience shortages. Despite the fact that there is an interest and desire for solid waste training at the federal, state and local levels there are no training activities at these levels or legislative authorizations or appropriations for solid waste training at this time. The current workforce cannot be significantly upgraded without EPA's assistance. However, the emphasis placed by EPA on manpower needs has diminished over the past eight years, an indication of the importance EPA places on the program."

Local Government Training Needs

At the local level, training is usually on-the-job. Formal on-the-job training usually involves training in performing specific tasks, e.g., operation of heavy equipment, etc. Equipment manufacturers usually provide some type of training in the operation of the equipment when the equipment is sold to a city or county government. At the local level, the solid waste management labor force can be divided into three parts:

1. Sanitary landfill operators - operators that operate the bulldozers, compactors, scrapers, crawler-loaders, crawler-dozers, payloaders, etc.

2. Managers of solid waste systems - local, state officials that actually manage the operating system; and

3. Government managers - enforcement inspectors, etc.

The Resource Conservation and Recovery Act of 1976 requires the local governments to conduct the following activities among others:

1. Developing solid waste management plans to meet state/RCRA requirements;

2. Procuring services to plan, design, construct, and operate solid waste management facilities consistent with RCRA developed plans (usually land disposal facilities and resource conservation facilities); and,

3. Gain the support of the public to develop and implement solid waste management plans.

According to OSW's "Manpower Development Policy Paper," local government activities include: planning; public participation; marketing analysis; design, construction, and operation of solid waste management facilities; monitoring of facilities to determine compliance with established regulations; and preparation of procurement requests for the acquisition of solid waste management services and facilities.[31]

Sanitary landfill operators often have to know how to operate the heavy equipment themselves. In 1970-73, according to an EPA employee with a wide range of former experience with local government operations, less than five percent of these people ever took any type of formal training in heavy equipment operation. Training in heavy equipment operations and maintenance is available from vocational schools which offer a certificate in heavy equipment operation and maintenance and diesel mechanics, as well as other areas. There is a considerable difference, however, in operating a bulldozer on dirt and soil and operating a bulldozer or crawler-dozer on trash and garbage. It is clear that instruction at the job site is needed on upgrading of various sizes of landfills and on how to operate varying sizes of equipment. Operators thus need training in heavy equipment operation and maintenance, and remedial training in proper landfilling techniques.

Because regional councils at the local level are an important component of planning in solid waste management, any training program which is developed and aimed at the local level should address the training needs of the regional council personnel as well. Regional councils could be utilized as an important part of the landfill siting process, developing of resource recovery facility planning, and the locating of hazardous waste management facilities.

PRIVATE SECTOR

Intent Under RCRA for Private Sector Training Activities

Industry is required to develop plans to meet the requirements of Subtitles C and D under RCRA and is to provide services to local governments to assist in compliance with RCRA. Industrial sources regulated by RCRA include those generating hazardous and non-hazardous solid wastes. Industrial sources have needs for trained personnel for: planning; design and construction of facilities, and operation of facilities; monitoring and surveillance of facilities to determine compliance with established regulations; preparation of suits for litigation; and, an understanding of the requirements of RCRA.

Much of the private sector training involvement is through professional associations which sponsor training programs and short courses for their members. This training is directed towards meeting the needs of industry in the supply of a professionally trained workforce. Appendix C contains a listing of training programs sponsored by private sector organizations.

Private Sector Training Activities:

American Public Works Association, Institute for Solid Wastes

The Institute for Solid Wastes is an organization comprised of approximately 1,800 public officials with solid waste management responsibilities in the United States. The Institute for Solid Waste currently conducts a training program on solid waste management which covers landfill siting and resource recovery. Landfill siting is presented to the operators and public works officials who attend these sessions. One day is devoted to technical matters and a second day is devoted to political aspects and public management discussions.

The faculty members from the Institute of Solid Waste conduct the training sessions. Personnel are borrowed from the local areas where the training is conducted to address particular topics. For example, during the resource recovery session an "information dump" is utilized. That is, information is obtained on what materials are being recovered, what can be done with materials from resource recovery and what can be learned from the resource recovery plants now in operation. Information is presented on frequency of collection.

The courses are designed for the operating professionals in that they are primarily for the director of public works or director of disposal operations in a local area. The basic training presented often consists of an update of basic civil engineering practices and includes topics on groundwater and soils. An emphasis is placed on changing the attitudes of the participants so that they can deal with a changing social and political environment.

Little training is available below the level of director in a local area. Training is presented by the APWA to their 60 local chapters; these local chapters are excellent places to start local training efforts aimed at the operators. There is a very definite need to upgrade the skills of those working in solid waste management operations. For example, seminars are needed in transfer station operation; and, criteria for landfill selection and operation. It is the opinion of those at the Institute for Solid Waste that the training need is greater at the operational level than at other levels.

There is also a training need for state landfill inspectors since a principal effect of RCRA will be at the state level. Food and milk inspectors may be able to be trained on-the-job for solid waste enforcement, but this may not apply to other types of inspectors.

There is no trained manpower at present in hazardous waste management. There are, at present, approximately ten to twelve states with hazardous waste management programs. The APWA membership does not manage hazardous waste disposal sites. The hazardous waste sites themselves are defined by the persons operating them. A pressing problem that arises for land disposal operators is how to handle the chemical sludges from the chemical as well as other industries. Training should be presented on this topic.

The APWA holds annual congresses. The recent Congress, held in Boston in October, 1978, had two parts: an equipment show and a technical show. The technical session contained training. There were two management sessions held. The first seminar was devoted to developing public works management skills which are considered to be an important future training need. During the technology update portion of the Congress, resource recovery information was presented to the attendees. For example, a new type of trash truck was available for the attendees to view. Areas of future training emphasis should include: groundwater monitoring; converting a dump to a landfill; leachate management; managing methane gas; and, collection system analysis.

National Solid Wastes Management Association

The National Solid Wastes Management Association represents the solid waste management industry in the private sector. At the present time, they do not have an ongoing training program for their membership. However, those attending the Association's biennial meetings (a Congress and a Technical Meeting) are exposed to the recent developments in the industry, and thus, have an opportunity to keep current with the state-of-the-art.

The Association's Seventh National Congress was held in San Francisco September 19-22, 1978. The Congress's theme was Outlook for Waste Management; Close-up on Accomplishments, Long View on the Future. The Congress was oriented toward Waste Management Technology and Resource and Energy Recovery. It featured forums on resource recovery, sanitary landfilling, and waste management. A listing of the topics that were discussed gives an excellent view of the current concerns of the industry:

Inspection Tour:	Visits to a sanitary landfill and two waste sites.
Land Disposal:	The National Land Disposal Site Survey - Will it Accomplish its Purpose? The Best Landfill Technology Can Produce
Hazardous Wastes:	Hazardous or Not?

Resource Recovery: Assigning the Risks of Resource Recovery

Shaping a National Resource Recovery Policy

Land Disposal - Siting: Where Will All the Wastes Go?

Hazardous Wastes: How Can Liabilities be Managed?

The Ultimate Disposal of Hazardous Wastes

Resource Recovery: The Resources Now Being Recovered

Several other private sector groups are currently (1978) conducting training programs or conferences which include training. These groups include:

National Wildlife Federation, Washington, D.C.
  Solid Waste Project: Wasteworks '78

American Society for Testing and Materials, Philadelphia, PA
  ASTM Symposium on Disposal of Oil and Related Materials and Debris Resulting from a Spill Clean-Up Operation

Association of Petroleum Refiners, Washington, D.C.
  Third International Waste Oil Recovery and Reuse Conference

Institute of Scrap Iron and Steel, Washington, D.C.
  ISIS Safety Seminar

National Association of Recycling Industries, Inc., New York
  NARI Southern Division Conference
  NARI Open Forum
  Paper Stock Institute of American Fall Conference
  NARI Precious Metals Workshop
  NARI Western Division Conference

Governmental Refuse Collection and Disposal Association, San Leandro, CA
  Safety for the Refuse Worker Training Program

National Center for Resource Recovery, Washington, D.C.
  Resource Recovery '78: One-day conference on the state of resource recovery in the U.S.

Government Institutes, Inc., Washington, D.C.
  Third Annual Toxic Substances Control Conference: Includes discussion of RCRA regulations for hazardous wastes management.

Many personnel employed in the private sector solid waste labor force feel that the EPA has not really served their training needs. It is debatable, in the view of officials of the National Solid Wastes Management Association, whether there is a real need for EPA training assistance to the private sector, except to function as a disseminator of information. Certainly EPA is not in a position to pioneer new technology and management procedures for refuse collection. Most of the developments in the solid waste management field are a product of the economic pressures in the field at both the municipal and private sector levels. Changes in productivity and improvements in productivity are affected by many real world variables which cannot be influenced by the actions of the EPA.

In the solid waste disposal area, EPA serves as a catalyst to encourage training by the materials it has developed to date. EPA has had an impact and deserves credit for the efforts it has made in the training of disposal personnel.

Management of hazardous wastes is a new area in which the EPA does not have a real in-house experience base, according to representatives of the private sector solid waste management workforce. The EPA staff is planning and research oriented, and usually has not actually operated hazardous waste sites or hasn't otherwise been involved in the handling of hazardous wastes. Overall, no formal training capability exists in the handling of hazardous wastes at the present.

Specific Occupational Training Needs

Planning

Most of the state solid waste management planning is done by local consulting firms under contract to prepare local and regional plans. Few states have an adequate in-house staff to prepare the plans internally, and most states prefer to allocate the planning responsibilities to the local and regional jurisdictions within the state. Because there are not enough adequately experienced planners on the staffs of cities and counties to be able to prepare consistent plans, there is a lack of consistency regarding even the best of plans. Thus, states need to be able to find good consultants and provide them with the proper guidance to develop good, workable plans. Many of these consultants have had prior experience only with water quality management plans. Solid waste disposal is different from sewage treatment in that it is more labor-intensive rather than capital-intensive and, in this regard, is more allied with the construction trades. This difference means that skills used in other facets of waste disposal are not transferable to the field of solid waste. Those involved in the planning process should understand this difference.

Regulatory Personnel (Enforcement, Surveillance, Monitoring)

According to representatives of the private sector, there is an absence in most states of adequately trained enforcement personnel. States simply do not have the money to train all the personnel who need training. Thus, the absence of qualified enforcement personnel is a chronic problem in most states.

Enforcement by states has been very sketchy. While some states have very good enforcement policies and staffs, other states have very poor policies and staffs. Experienced and qualified professional personnel are necessary if land disposal regulations are to be properly enforced. The private sector labor force will, in turn, benefit as it is more efficient to operate under a uniform regulatory program managed by good competent personnel. It requires a professional with a good engineering background (e.g., civil engineering or some background in environmental aspects of wastewater treatment, groundwater, etc.) and an understanding of water quality as well as solid wastes. To be qualified to serve as an enforcement inspector, recent workforce surveys indicate that it is necessary to possess a Master's degree in the field. There are at present few jobs available for the preparation of enforcement personnel to enter the labor force at the state level, not to mention the absence of a strong market for the personnel once they are trained.

Technical and Research Personnel

There are probably more qualified people now in the field than the market can support. There are many consulting firms now working in the solid waste field and experimenting in the technology. High technology talent is now coming from all directions (especially from the wastewater, water, and air fields).

The EPA is relying on contractual agreements with consulting firms for its Technical Assistance (TA) Panels program. There are some serious problems with this system from a management standpoint, such as who is doing the consulting and what are their qualifications.

Supervisory Personnel (Managers of Collection/Disposal Systems)

From the point of view of industry, there is little that the EPA has done or can do to contribute to the overall improvement of management skills in the collection, landfilling, and the handling of hazardous wastes. And there is even less that EPA can do for the labor force in the collection and disposal of wastes. The management of a refuse collection program requires an intensive knowledge of the study of time and motion, and the labor force. It also requires an intrinsic knowledge of transportation (e.g., vehicle routing, vehicle maintenance, scheduling, planning, etc.), most of which can only be derived through experience.

Private solid waste management representatives do not forsee a training need and believe that there is an adequate manpower base for their activities. It is difficult for government bureaucracies to remain sensitive to what is needed to run a business.

Operational Personnel (Landfilling)

Representatives of the private sector believe that landfill operations personnel have adequate training through on-the-job activities. The training that they receive is generally obtained by coming up through the ranks of the construction industry.

The equipment manufacturers (e.g. Caterpillar, Deere, National, etc.) have field representatives who know how to use the equipment properly. Thus, the field distributor is an accessible source of knowledge, based on experience and training and can provide the operators whatever instruction is needed for the operations and maintenance of their equipment. Therefore, these landfill drivers do not require an EPA or state sponsored training program to assist them in learning how to operate their equipment.

Consultants

Consultants are active participants in the process of providing services for the development of state, local and industrial plans to meet the Subtitle C and D requirements contained in RCRA. They are also a force in the implementation of the plans and in the siting, designing, constructing, and operating of solid waste management facilities.

Consultants are engaged in assisting the EPA in providing services to local areas through the TA Panels Program. Contractors and grantees of the TA Panels Program have also been targeted as one of the three main receptor groups (the others are EPA and state personnel) to receive the primary focus of Office of Solid Waste manpower development and training efforts.

UNIVERSITIES

University/College Involvement in Solid Waste Training

The EPA involvement in supporting university level training programs has rapidly declined over the years. The Office of Solid Waste Management programs at one time had about thirteen graduate level university training programs funded. There currently appears to be few solid waste training programs in existence with specific solid waste management curricula. Most of the specific training courses are offered by university engineering extension services or continuing education programs. At the undergraduate and graduate level, most environmental engineering or environmental science/studies programs offer one to two courses in solid waste management but not much more than that. However, there are a few environmental programs which offer an option with a series of courses specifically oriented to solid waste management.

According to the EPA Office of Solid Waste's study, "Manpower Development Policy Paper," written in response to Section 7007 of RCRA: ". . . there are many that will need training and there are few that can provide training that is consistent with the intent of RCRA and the policies of EPA. A program, therefore, will clearly have to be established to develop the necessary manpower needed for RCRA."[32]

A primary incentive for university involvement in solid waste management training was the EPA training grant program. A total of 29 grants were made to universities between 1968 and 1978. This is illustrated in Table 11. The program reached its peak in 1972 with a total of eleven grants awarded. Following OMB's request to phase out academic training grants, the program all but disappeared. Most of the grants were awarded to universities offering graduate degrees in engineering with a major or option in solid waste management. A listing of the universities receiving training grants appears in Appendix D.

Current University Views

Each of the academic solid waste training grant programs had a director and seven of these university professors were contacted for their views. Only three were still at the universities which had the training grants; The University of Michigan, Georgia Institute of Technology, and the University of Illinois. The other four are now located at Duke University, Hofstra University, the University of Texas at Austin, and the University of Florida at Gainesville. Their individual views represent a diversity of opinions concerning solid waste management training and are summarized as follows:

Duke University - Durham, North Carolina

> The EPA's solid waste training program had a definite impact on providing what skilled labor exists in the solid waste management field today. But it was not enough and, with the passage of RCRA, even more training is needed. However, it is felt that the EPA has abdicated its responsibility in terms of training at all levels, e.g., operators, professionals, etc. The training program's termination has had the effect of reducing the quantity and the quality of the personnel available in the workforce, although on-the-job training has probably kept many of the skilled personnel current with the state-of-the-art.

Duke University sources recommend that the EPA reestablish the solid waste training program on a regional basis. This would ensure that certain standards are met. If the EPA cannot operate the training program itself then the program should be set up on a regional or statewide basis. EPA's imput would ensure consistency.

Training should begin at the university level for those who will be managers and at the community college level for those who will be technicians and operators. States and other governmental agencies should conduct their own training programs for their own staffs as well as for operating staffs.

Hofstra University - Hempstead, New York

Hofstra University Engineering Department officials believe that a large percentage of the workforce will be needed at the industrial and local government level. At the industrial level, few companies currently have the expertise to properly manage their problems as required by RCRA. Local governments are usually without adequate finances to hire the workforce that is required. It is believed that an adequately trained workforce exists only at the enforcement and design level. At the present time, solid waste management personnel receive most of their training on-the-job.

It is believed that the EPA training grant program had only a minor impact on providing what skilled labor force that existed at the time the program was operating. Also, termination of the program probably had no effect on reducing the skilled labor force as it exists today.

Future solid waste training should be conducted by educational institutions under the direction and coordination of local governments. State agencies should assume the function of review, while the Federal government should provide the financing of solid waste training programs. After a certain level of expertise is attained, the burden of financing could be shifted to the individual obtaining the training.

The decision as to which topics to cover or to give greater emphasis in a solid waste training program would depend on the individiual's position in the field itself. For example, a manager would be primarily concerned with financing of solid waste facilities; collection of solid waste; and land disposal practices. Operators are concerned with operation and maintenance of the plant and collection and disposal of solid wastes.

University of Michigan - Ann Arbor, Michigan.

Financing of solid waste training activities should be by the Federal government, at least initially. Later, training could be provided by groups such as the American Public Works Association and the National Solid Wastes Management Association.

Land disposal practices should be emphasized by any training program aimed at sanitary landfilling operations. Monitoring should be a large component of any such training oriented toward landfilling. Landfill operators need to know how to deal with potentially hazardous wastes management areas. EPA will thus have to start from ground zero and give state enforcement inspectors a great deal of training in this area.

University of Texas - Austin, Texas

Civil Engineering Department officials have intergrated solid waste management and hazardous materials subjects into parts of other courses. University officials believe training is needed in determining how hazardous and other toxic materials affect the water and the air.as these are the areas where the greatest public awareness exists.

Operating personnel can obtain training from technical schools which offer programs such as the operation of a bulldozer or safety for collection crews, etc. This type of training can also be obtained through university extension services. Management personnel, particularly for engineering and design of operations, can obtain training from a training program offered off-campus so that extensive travel is not involved. This does not necessarily have to be a degree program. A basic problem is providing the consulting engineer with the maximum exposure to the field in order to get that person(s) involved in making decisions on the disposal of solid and hazardous materials.

University of Florida - Gainesville, Florida

Past solid waste training efforts have taken two forms: one form is for the technicians, and the other form is for the research scientists. There has been relatively little training effort directed at engineers or those people who have to take the science and convert it into a workable plan which can be implemented by the technicians. The education of personnel whould be directed toward the practice of engineering in the solid waste field. The personnel would thus become design and management personnel and would have an educational program that is a mix between management and administration on one hand and pertinent engineering on the other.

There are very few efforts in the United States directed toward trying to develop effective scientifically-based-approaches to the handling of hazardous wastes. This effort should be a part of a training program's activity. An academic program may not be the answer. What is needed is a combination of practice or on-the-job training under the guidance of experienced personnel and with the assistance of academicians with the theoretical background (extension program).

Georgia Institute of Technology - Atlanta, Georgia

Georgia Tech officials indicated that there are few aspects of solid waste management which have an adequate number of sufficiently trained personnel at present. They feel that the most immediate need in bringing the number of professionals in line with the demand for them, is to ready trainers and educators, who, in turn, may competently respond to the challenge of workforce preparation. Additional competent personnel are required at all levels, and there is a need to establish recognized leadership, i.e., persons capable of disseminating the required body of knowledge of the field and those who are capable of taking on the task of implementing sound solid waste strategies on a nationwide scale.

To date, regulatory agencies have often needed to pull persons from related fields (e.g., wastewater treatment), when, in fact, these newcomers to the practice of solid waste management have little preparation or knowledge which pertains specifically to the field. This all too often results in judgements and decisions which are inappropriate and thus tends to perpetuate the lack of understanding surrounding the demands of the profession. This also places additional demands on those persons who are adept in the profession to educate those with a less than adequate familiarity with the necessary aspects of solid waste management.

Operator training is best learned on-the-job; technical training should be taught in the technical or trade schools, not in the universities; and supervisory, planning, management, etc., training belongs initially in the universities where students aspiring to administrative positions may learn the scientific/technical bases and fundamentals of their field.

The goal of education should not be to try to train administrators, rather, it should be to train competent engineers and scientists who will be well-versed in the basic principles of engineering and physical systems in general. Some specifics of the application of engineering and science

> to the field of solid waste management will definitely have to be learned on-the-job because of the ever-changing technology in an emerging field. The science or engineering foundations must be solid and extensive.
>
> Students are not prepared to spend their own money on the pursuit of a program which has an ill-defined end in the job market, as seems the case with solid waste management, no matter how promising the actuality of the situation may be. Students feel that they are better advised to get a training grant or stipend from a department or program which is better identified, perhaps in a field they consider to be related, so that they can practice solid waste management should the occupational opportunity present itself.
>
> The University of Illinois - Champaign - Urbana; Illinois
>
> The University of Illinois still offers one course in solid waste management, directed primarily to agricultural engineering (feedlot, waste management, etc.).

Because of the high costs of an education, most students enroll in programs where they can receive financial aid. Therefore, many, though interested in the field of solid waste management, do not continue in the field. Because the EPA does not encourage unsolicited proposals from the academic community, there is little creativity coming out of the solid waste academic field at this time. Therefore, no initiative or resourcefulness is used in finding new solutions. Solid waste management belongs in more than one medium (air, water, etc.) and crosses media lines.

Solid waste management is not publicly perceived as a top priority and so it will probably lose what little support it has until there is some sort of a crisis. The potential health hazard of solid waste handling is possibly one area which may get some attention in the future.

Extent of Current University Involvement in Solid Waste Training

In the process of reviewing university/college catalogs for solid waste management programs, it was determined that there are at least 77 programs offering training/courses. A breakdown by level of training is illustrated in Table 14.

TABLE 14

University/College Programs with Training in Solid Waste Management

Level	# of Programs
Graduate	39
Undergraduate/Graduate	21
Undergraduate Only	6
Undergraduate/Associate	1
Associate Only	8
Associate/Certificate	1
Certificate	1
TOTAL	77

Most of the schools offering solid waste management courses did not offer more than one or two and considered them to be a program emphasis, specialization, or option rather than a complete program. A complete listing of the colleges and universities offering courses is shown in Appendix E.

HAZARDOUS WASTES

Authorization Under RCRA

Section 3004 of the Resource and Recovery Act of 1976 authorizes the Administrator of the U.S. Environmental Protection Agency to promulgate regulations establishing standards applicable to owners and operators of hazardous waste facilities for the "training of personnel" (employed at facilities) as may be necessary to protect human health and the environment.

Subtitle C of RCRA mandates the establishment of a regulatory control program for the management of hazardous wastes. It is clear that Congress intended for the states to implement hazardous waste control programs as part of their comprehensive solid waste management strategies.

Regulation providing for comprehensive training in hazardous waste management are necessary primarily because of the potential damage to public health and the environment. Training will help allieviate the number of cases in which waste materials were improperly stored, transported, treated and disposed. The techniques used in managing hazardous wastes will increase in complexity, and new technological advances will be developed. Regulatory demands for increased operating efficiency will require a large and well trained workforce at subprofessional and professional levels.

The Hazardous Waste Management Division of EPA's Office of Solid Waste is responsible for the conduct of such a program with the administrative support of the Management and Information Staff.

In order to implement this, the Division, on December 15, 1978, released a draft document relating to Section 3004 of Subtitle C, and this "Draft Background Document: Section 250. 43-4, Standards for Training" constitutes the proposed EPA policy concerning training for hazardous waste facility personnel.[33] The principal proposals are:

(a) Within six (6) months after the effective date of these regulations, or date of employment, personnel at new and existing facilities shall have attended and successfully completed a course of instruction in hazardous waste management procedures, as prescribed in EPA's "Training Manual" for owners/operators of facilities relevant to those operations, at which the employee is employed, at the facility.

(b) Owners/Operators of facilities for the treatment, storage or disposal of hazardous wastes shall

  (1) maintain the following records, and make them available to the Regional Administrator upon request:

    (i) a list of the job titles of all positions at the facility related to hazardous waste management.

    (ii) a written job description for each position listed under (b) (1) (i) which shall include the requisite skill, education, responsibilities and duties related to each position;

(iii) a written description of the type and quantity of introductory and continuing training that will be administered to each person filling a position listed under (b) (1) (i).

(iv) records that document that the training required under (a), has been administered to facility personnel;

(2) have their personnel trained in contingency procedures as prescribed in the facility's contingency plan required under Section 250. 43-3, and

(3) have their personnel take part in an annual review and update of their initial training in contingency procedures, and other hazardous waste management procedures relevant to those operations, at which the employee is employed, at the facility.

Federal Training

Starting in 1973 with the establishment of the EPA Hazardous Waste Management Division, a program of technical assistance was created to assist in the management of hazardous materials. Subsequently, this Division's efforts were directed toward the creation of similar units within the EPA Regional Offices. Teams of experts were sent from EPA headquarters to investigate incidents of improper hazardous waste management practices and to advise on safe practices and remedial measures.

If hazardous waste management practices are to be improved, EPA must consider the training needs of the people who are now or will be involved in hazardous waste management activities. States must place workforce needs on a priority equal to their concerns for hardware and legislation. They must be encouraged to look at their workforce needs from the very beginning of their programs so that their survey, planning, and legislative efforts will not later be found to be wasted.

Mr. Thomas D. Gillard, P.E., an engineer formerly attached to the Solid Waste Management Branch, Hazardous Materials Control Division, EPA Region VII (Kansas City), wrote an early paper concerning training and workforce development needs in hazardous waste management. This paper, "Training and Manpower Development Considerations in Hazardous Waste Management" was written in 1974 and is probably one of the best discussions of workforce and training needs written on the subject. Highlights from this document are summarized as follows:[34]

- By considering manpower needs from the earliest stages and throughout the program, it may be possible to develop programs which draw on the strengths of the personnel and to eliminate those programs which cannot be realized due to personnel restraints.
- The study of hazardous wastes must include the training and manpower needs of the particular system designed to dispose of the wastes.
- The evaluation of existing and proposed hazardous waste management systems cannot be complete without considering manpower needs. By placing people on the same level as technology and regulations, an effective hazardous waste management system can be achieved.
- Questions to be asked when evaluating any system, existing or proposed, which relies on the skills of

people rather than solely on the mechanical functions of some machine:

  a. Who are the people involved in the system?
  b. Do they have the skills necessary to perform their function in the system?
  c. Can knowledge gaps be eliminated?

- In proposing alternative systems for hazardous waste management, manpower needs would be considered if the following points were addressed.

  a. Who will be involved in the management and operation of the system and the role of each person?
  b. The availability of any personnel who could adequately perform the proposed role.
  c. Where and how these knowledge gaps could be closed.
  d. Is it in fact possible to fill the training needs and what delivery systems are available that could be developed to do so?
  e. Keeping in mind the answers to the above queries, can these manpower needs be met and what will the cost be?

- Evaluating whether personnel working with existing systems or who would be part of a proposed system are capable of adequately performing their role may be difficult. This requires an analysis of the skills required and the skills available. When a problem area is identified, there is a tendency to look for a deficiency in equipment and propose new equipment and facilities without considering the possibility that existing personnel are not properly trained in its use.

- After the training needs are identified, delivery systems should be investigated, including those systems previously used. Other systems, unique to hazardous waste management training, will have specialized needs and will require particular areas of expertise in the institutions considered as potential training delivery systems.

In his paper, Gillard identified specific categories of personnel who will require hazardous waste training, the types of training needed for each category and the anticipated delivery systems likely to provide the training. These are illustrated in Tables 18 and 19.

TABLE 15

Categories of Personnel Requiring Training and Training Needs

Recipient	Training Need/Knowledge Gap
I. State/EPA	1. Knowledge of hazardous wastes (a) industries involved (b) treatment/disposal options
II. Generating Industries	
A. Management/Technical	1. State/Federal HWM programs 2. Knowledge of *their* hazardous wastes 3. Treatment/disposal options for *their* wastes
B. Operating Personnel	1. Hazards presented by *their* wastes (a) to themselves (b) to haulers (c) to environment 2. Treatment/disposal options available for *their* wastes
III. Hauler or Transporter (other than those directly associated with treatment/disposal operation)	
A. Management/Technical	1. State/Federal regulations 2. Knowledge of wastes they and others in their area handle. 3. Treatment/disposal options available in their area.
B. Operating Personnel	1. State/Federal regulations -- programs 2. Hazards from waste being handled (a) to themselves (b) to environment 3. Treatment/disposal options available for wastes they handle - particularly, knowledge of their role responsibilities in treatment/disposal.

IV. Treatment/Disposal

- A. Management/Technical
  - 1. State/Federal regulations -- programs
  - 2. Knowledge of wastes they handle.
- B. Operating Personnel
  - 1. State/Federal regulations & programs
  - 2. Hazards of wastes they handle
    - (a) to themselves
    - (b) to environment
  - 3. Operating procedures.

Source: U.S. Environmental Protection Agency. Training and Manpower Development Considerations in Hazardous Waste Management, 1974.

TABLE 16

Categories of Personnel Requiring Training and Anticipated Delivery Systems

DELIVERY SYSTEM		Training Recipient						
		State/EPA	Generating Industry		Hauler or Transporter		Treatment/ Disposal	
			Management & Technical	Operating Personnel	Management & Technical	Operating Personnel	Management & Technical	Operating Personnel
EPA		L	L		L		L	
EPA Contractors		L						
University	Courses	L	U		U		U	
	Consultation	U	L		U		U	
Generating Industries	Contract	L						
	Consultation	L			L	U	L	
State Surveys		L	U		U		U	
Treatment/Disposal Operators		L	L	U	L	U		L
Individual Contact by State			U	U	U	U	U	U
Seminars and Trng. Cses.	State/Federal		L	L	L	L	L	L
	Trade Associations of Haulers & Disposers	L	L	L	L	L	L	L
	University	U	U		U		U	
	Local/Regional Authorities		U	U	U	U	U	U
	Generating Industry Organizations	L	L	U	U	U	U	U
Trade Associations of Haulers & Disposers - Newsletters, Technical Papers, etc.		L	L	U	L	U	L	U
Local/Regional Authorities	Individual Contact		U	U	U	U	U	U
	Newsletters, etc.		U	U	U	U	U	U
Generating Industries In-House	by Higher Level Management			L				
	by Technical Staff		L	L			L	
Engineering Consultant			L	U	L	U	L	U
Public School (Vocational-Education, Technical Schools)				U		U		U
Community Colleges				U		U	U	U

L = Likely
U = Unlikely but possible

Source: U.S. Environmental Protection Agency. Training and Manpower Development Considerations in Hazardous Waste Management, 1974

Another federal agency concerned with Hazardous Waste Management is the U.S. Army. The Hazardous and Solid Waste Management Division of the U.S. Army Environmental Hygiene Agency is the principal group managing the Army's hazardous wastes. The job titles of the personnel in the division include: chemists, engineering technicians, a sanitary engineer, an environmental scientist, an entomologist, and a physical scientist technician. According to Agency officials, there is no one discipline that personnel could be trained in which would enable them to handle all the problems associated with the management of hazardous wastes. In their opinion, no programs exist that could adequately train an individual to become totally responsible for the disposal of hazardous wastes.

Officials of the U.S. Army Environmental Hygiene Agency cannot recruit civilian personnel to work in the management of hazardous wastes because civilian personnel are not currently trained properly in this area. Those who are hired for this work by the Agency must be trained on-the-job to manage hazardous waste materials. It is also their opinion that the EPA as well as state regulatory agencies will experience the same personnel problems.

Evaluation of a company's hazardous waste disposal methods would require that a person be trained in chemistry, geology, and environmental science or engineering. It would be very difficult to recruit personnel trained in all three areas and very cost and time prohibitive to train them. An alternative solution would be to train an inspector to investigate the site and to prepare a report based on the findings. If the standards have not been met, an expert team can be sent to the site to investigate the problem later. A second alternative would be to send a chemist, a geologist, and an environmentalist to an intensive two-year training program in the other areas. When they have finished their program, they would then be sufficiently knowledgeable in most of the areas relating to the management of hazardous wastes.

It will be very difficult for the states to prepare and implement hazardous waste management programs in their comprehensive solid waste management plans until EPA develops guidelines for the states to follow when setting up their programs. Section 3000 regulations are scheduled to be published in the summer of 1979.

The sources of solid waste that the Army has to deal with are as follows: conventional munitions, large conventional munitions, excess laboratory chemicals, hospital infectious wastes, and sludges.

The concern of the U.S. Army Environmental Hygiene Agency is the disposal of wastes in an environmentally safe manner. Although the Agency does not conduct any formal training for its staff, it has developed a computer program where methods of disposal of hazardous wastes are stored for future reference. This historical data provides the Army with information which is readily available to its other divisions. Currently, there are 1,900 items stored in this data base. Disposal instructions include the following topics: how to dispose of the materials, incineration, pollution, landfills, health hazards associated with disposal methods, and protective clothing to be utilized. A chemical compatibility guide was also developed for storage purposes for the Defence Logistics Agency.

Most of the Army's training on this subject has been on-site although environmental management courses have been offered at installations such as Fort Lee, Virginia, where environmental engineers and scientists receive training in the appropriate laws and regulations. Training is also offered in specific subject areas, e.g., how to handle infectious wastes, etc. Safety training is needed in the handling of hazardous wastes to prevent accidents, however safety personnel often do not have a background in the particular field that they are trying to protect. This is particularly true in the handling of hazardous waste materials.

Officials of the Environmental Hygiene Agency forsee particular difficulties for small companies which often handle large amounts of chemicals, because these companies do not have the money to hire a staff responsible for ensuring that the company complies with the requirements of RCRA.

State and Local Training

The Resource Conservation and Recovery Act encourages the states to establish and implement hazardous waste regulatory programs. Their training needs encompass the following areas: planning, technical assistance (which includes the training of local and industrial personnel), public participation, technical information development and delivery, the permitting of facilities, the monitoring and surveillance of facilities, and the preparation of litigation for the enforcement of solid waste management regulations.

Local governments are to develop solid waste management plans which meet the state and federal requirements; procure services which are to be used to plan, design, construct, and operate solid waste management facilities consistent with the plans developed by RCRA (mostly land disposal facilities and resource conservation facilities); and to gain the support of the public to develop and implement solid waste management facilities. Their functions include planning, public participation, marketing analysis, design, construction and operation of solid waste management facilities, monitoring of facilities to determine compliance with established regulations, and preparation of procurement requests for the acquisition of solid waste management services and facilities. It is almost as difficult to identfy the responsibilities of local government in the management of hazardous wastes as it is unclear as to how they will be incorporated into state hazardous waste management programs. Consequently, training needs cannot be addressed or identified at this time. States will have to involve local governments in the hazardous waste siting process as this will be an area of great concern to local communities and counties. Personnel from public works agencies and civil preparedness agencies have attended seminars in 1978 sponsored by the National Fire Protection Association on the handling of hazardous waste spills during their transport.

According to a speech given on October 16, 1978 by Steffen Plehn, the EPA Deputy Assistant Administrator for Solid Waste, to the American Public Works Association, "18 states have recently enacted or perfected their own hazardous waste legislation, and we currently expect about 40 states to apply and qualify, at least for interim authorization to operate the program".[35] The "Annual Report for the President and the Congress for Fiscal Year 1977: EPA Activities Under the Resource Conservation and Recovery Act of 1976"[36] stated that hazardous waste management legislation has recently been enacted by the States of California, Illinois, Oregon, Maryland, Missouri, Washington, Oklahoma, Minnesota, Kansas and New Mexico. This document also reported that, "In 1977, California adopted replacement legislation to bring the state authority in line with RCRA. Texas has actively developed its program for managing the land disposal of hazardous wastes under the legislative authority of its water pollution laws rather than under a state hazardous waste management act. Several other states are now considering hazardous waste legislation, including Iowa and Wisconsin."

In a 1978 document entitled "Draft Background Document: Sec. 250, 43-4, Standards for Training", [37] EPA identified the specific types of training needed for hazardous waste management personnel. This training includes:

Formal Training

A). Environmental awareness: considers the potential public health and environmental consequences resulting from mismanagement of hazardous wastes.

B). Contingency procedures: prevention and handling of explosions, fires, leaks, spills, and accidental emissions.

C). Environmental sampling and monitoring: techniques and analyses.

D). Basic skills: chemistry, mathematics, physics and laboratory techniques applicable to hazardous waste management.

E). Treatment processes and systems: (biological, chemical, and physical) characteristic of hazardous waste management facilities.

F). Equipment operation and maintenance.

G). Local, state, and federal regulations affecting hazardous waste facilities.

H). Proper procedures for handling hazardous wastes; involves proper DOT shipping names, classes, required packaging, compatibility, labeling, marking requirement, placarding and shipping documents.

On-Site Training

Option 1: Supervisors must conduct on-site training of personnel in facility operations and emergency procedures which shall include but shall not be limited to the prevention and handling of explosions, fires, leaks, spills and accidental emissions.

Additional Periodic Training

Option 1: Personnel shall attend appropriate seminars, conferences, and/or refresher courses periodically as conditions warrant.

State enforcement personnel must be well-trained in order to properly manage a state hazardous waste management program. They must have a knowledge of the hazardous waste industries involved and a knowledge of the treatment and disposal options. Enforcement personnel of the states must be trained in the following broad areas:

a. Environmental awareness of the potential consequences resulting from mismanagement of hazardous wastes.
b. Contingency procedures for the prevention and handling explosions, fires, leaks, spills, and accidental emissions.
c. Environmental sampling/monitoring techniques/analyses.
d. Basic skills of chemistry, mathematics, physics and laboratory techniques applicable to hazardous waste management.
e. Treatment processes and systems.
f. Equipment operation and maintenance.
g. Local, state, and federal regulations affecting hazardous waste facilities.
h. Proper procedures for the handling of hazardous wastes.

Because there are many different types of potentially hazardous materials that will eventually fall under the regulatory programs, enforcement inspectors must be able to determine whether the waste in question is hazardous or not and be able to give on-site advice on how it should be handled. This may prove too much for most inspectors because extensive training may be required to become properly knowledgeable. But they should be able to determine whether or not a material is being properly handled according to the criteria and standards that will be established and if not, then should be able to call upon other state personnel for technical assistance.

The state enforcement agencies should be encouraged to develop programs to train their enforcement personnel properly and to keep them up to date on regulatory developments. This may require courses or training programs that are modular in design be offered by the states with the assistance of universities, private associations, and engineering extension services. The states may require the assistance of the Federal government to establish such needed training programs. Technical assistance teams will probably have to be formed by the state agencies to respond to requests by the generating industry for information on treatment/disposal techniques. These personnel will also require the proper training to provide such services.

Private Sector Training

Individuals or industries generating potentially hazardous wastes will be charged under RCRA with determining whether or not their waste materials are hazardous according to the EPA published lists and characteristics. If it is hazardous, according to the criteria, they must either properly manage it on their property or ship it to a permitted treatment, storage, or disposal installation. It is clear that some basic instruction will have to be provided to the generators on how to determine whether or not a material is "hazardous" according to the published criteria.

Foster D. Snell, Inc., prepared a report for the EPA Hazardous Waste Management Division in 1976: "Potential for Capacity Creation in the Hazardous Waste Management Service Industry."[38] The report found that in 1975 there were approximately 95 firms in the industry operating 110 facilities. Of a total approximately 2,000 employees in the hazardous waste management industry in 1975, approximately 11 percent were classified as professionals. Of these, 75 percent were chemists or chemical engineers. Of the firms that Foster D. Snell, Inc., interviewed, 80 to 90 percent had established internal on-the-job training programs for new entries. It was determined that skilled employees with chemical or waste treatment backgrounds were generally not available to the hazardous waste industry. The firms interviewed did hire professionals with experience in the waste treatment or disposal industry, when available. These professionals with positions in operations management, engineering and laboratory work, had specific environmental or chemical expertise.

Industry sources indicated that the fields of chemistry, geology and chemical engineering are the most suited for the management of hazardous wastes. The fields of transportation planning, accounting and environmental law are also especially useful. It is clear that some type of training should be provided to assist the private sector in meeting the problem of handling and disposing of these wastes. Possibly a series of short courses (one to two days in length) with a follow-up manual could be presented to industry personnel for their use. The EPA could develop these materials and present the material to the private sector through the regional offices.

RESOURCE RECOVERY

EPA Training

OSW's Resource Recovery Division has the general responsibility for the development and management of the orientation program. It is to be developed through the use of contractors and grantees. All divisions of the OSW participate in the development of the specialized training programs for EPA, state, or other personnel to assist them in the implementation of RCRA.

State and local governments receive technical assistance through the Technical Assistance Panels Program which is operated out of the EPA Regional Offices. Financial assistance is also being provided to the states for the development of urban resource recovery projects. Two-day Resource Recovery Implementation Seminars have been held in various parts of the country. They serve as an orientation to the implementation of resource recovery, both through mixed-waste processing and source separation.

A provision is included in the Guidelines for Development and Implementation of State Solid Waste Management Plans[39] for state activities to include technical assistance, training, information development dissemination, financial support programs, and programs to develop markets for recovered materials and energy. It is clear that EPA, working through the Regional Offices, could assist the states in the development of these activities.

State Training

In the area of resource recovery, states are encouraged to provide, in their State Solid Waste Management Plans, for development of training, information development and dissemination, and technical assistance activities.

It appears that there is little that state solid waste management agencies can do in providing training for their employees in resource conservation and recovery except for sponsoring seminars and conferences to develop a general awareness of new technologies in the field. State agency personnel could benefit from training in the areas of: review of state/local laws and regulations pertinent to contracting for resource recovery services or facilities; identification of the available and potential markets for recovered materials; the conduct of feasibility studies; and introduction to source separation, resource conservation and mixed waste processing.

It appears that many of the states have been taking the initiative in working through their engineering extension services at state universities to develop short courses and conferences on the subject of resource recovery. The following programs have recently been offered:

1. Hofstra University, Hempstead, New York. Offered by the Continuing Engineering Education program of Hofstra University, a certificate was awarded to those participating in the Solid Waste Management Program. This program was sponsored by the New York State Department of Environmental Conservation, the U.S. Environmental Protection Agency, and nationally recognized technical and professional organizations involved in solid waste management. Two courses were offered in May, 1977, in incinerator technology; one on sanitary landfilling and another

on resource recovery. The resource recovery course was designed to review the current state-of-the-art energy and materials recovery from solid wastes. The course was designed for public officials, engineers, and operators of solid waste management facilities.

2. Iowa State University, Ames, Iowa. Solid Waste to Energy Conference; The Ames Experience. Offered in March, 1978 by the departments of Industrial Engineering, Mechanical Engineering and Engineering Extension of Iowa State University, with the assistance of the City of Ames, the conference was designed for city managers, public works directors, consultants, practitioners, and researchers in solid waste resource recovery. The three-day conference included a tour of the Ames Solid Waste Recovery System and covered the following general topics: Management and Fiscal Requirements, Operations and Economics, Uses for Recovered Materials, and Solid Waste Management as Public Enterprise.

3. The Pennsylvania State University, University Park, Pennsylvania. Resource Recovery Course, May 20, 1978. Offered as a continuing education service of the Pennsylvania State University College of Education, the resource recovery course was developed to avoid the "nuts and bolts" approach to resource recovery systems. The course emphasis was on the application of technology to small and medium sized communities based on markets, service population, and dependability of service design. Basic mathematical formulations were used to demonstrate the effects of a range of process variables.

4. The University of Michigan, College of Engineering, Ann Arbor, Michigan. Engineering Summer Conferences; Fuel and Resource Recovery from Municipal Solid Wastes, July 30 - August 4, 1978.
Presented in cooperation with the National Center for Resource Recovery, the course was planned for engineers, systems planners, public works officials, government professionals, industry solid waste managers and others interested in the municipal decision-making processes of solid waste disposal and resource recovery. The course was structured to familiarize attendees with the technology, economics, and institutional factors of planning and implementing the recovery of solid wastes wastes as an alternative to disposal.

Private Sector Training

The majority of resource recovery plants in the United States are currently being operated by private industry. At present, municipalities demonstrate little interest in operating resource recovery facilities on their own. There are a variety of resource recovery plants utilizing different operating processes in the United States today, and no two plants are exactly the same.

When a request for proposal for the construction of a resource recovery facility is issued, a training requirement is usually included. This requirement is normally in the form of a five-year lease agreement with the company which intends to design and operate the facility. Usually the firm that designs the facility also operates it. These plants must meet environmental and economic standards in order to be feasible. For this reason, companies usually recruit operators with an engineering background and experience. If necessary, the company will train or have its personnel trained to meet the environmental and economic criteria. This method of training their own supervisory and operating personnel through a combination of formal and on-the-job training seems to work well, according to industry sources.

CERTIFICATION

State certification of solid waste personnel is an idea which has been frequently discussed over the past several years. Most of the people in favor of the idea would like to see a certification program established similar to those already operating for water and wastewater treatment plant operators. They also see it as a mechanism by which solid waste personnel can receive training and by which uniformity of standards can be ensured.

The National Academy of Sciences in a 1977 report to the U.S. EPA, "Manpower for Environmental Pollution Control"[40] considered certification efforts and concluded that:

> "There is little motivation in the private sector to develop certification programs, and this development may have to come from the government and from professional societies. Since the turnover rate for environmental personnel in industry is large and since a number of people become involved in pollution control activities on a less than full-time basis, certification requirements should not be so complicated that people cannot complete the requirements in a reasonably short time, with periodic reexamination and upgrading through the use of short courses and continuing education."
>
> "Certification requirements should be developed on a state basis because requirements vary significantly from state to state, particularly in areas such as solid waste management, community noise control, and pesticide application management. Full participation of the private sector should be encouraged in the development of certification programs and the conduct of certification procedures. In the past, certification programs have emphasized municipal wastewater treatment; such programs should be expanded to all industrial wastewater, air pollution control, and solid waste management programs."

It is important for the states to consider the audience for which state certification would be directed. Should it include state regulatory personnel and landfill operators only? It is important to consider thoroughly the possible benefits from a state certification program to ensure that it does not become a meaningless bureaucratic exercise. In the process of preparing this report, representatives of EPA, states, universities, counties, local government and the private sector were contacted for their views on the subject of certification.

EPA Views

Representatives of the EPA's Office of Solid Waste suggested that there is a need for certification and thought it should or would follow the pattern already established for wastewater treatment. Although certification programs would vary from state to state, it would be aimed primarily at the operational level. EPA representatives suggested that certification including regulatory personnel should be considered since they will be required to make some difficult enforcement decisions. Field inspectors may have to go out to make determinations, and it may be important to require certification since they have to stand by their decisions. Certification could increase the competence of field inspectors. For example, a requirement for inspectors to be licensed professional engineers could be included in a certification requirement, but this may prove impractical because few states would have either the budget or staff to accomplish this. For the certification examination, questions should be structured to measure the ability of the inspector to evaluate the disposal sites accurately.

It must also be ensured that the field inspector has the necessary background and training to be making these decisions since many of these could become matters for the courts to decide.

Other EPA officials differed and could not see a certification need for high level planning or management officials. They see a certification need at the lower levels, e.g., landfill operators; landfill managers; collection system managers, etc. A career ladder would be established similar to wastewater based on various grades of operators. Any certification program would have to be run by the states, which must implement and enforce the federal and state regulations. For uniformity of training and certification, however, there should be a national organizing body established for a solid waste certification program. It could be set up similar to the Association of Boards of Certification (ABC) for the wastewater and water treatment plant operators.

Agency officials suggested that one of the difficulties in the solid waste field is the quality of the people who operate solid waste management facilities. If the personal commitment of people to do the best job possible could not be obtained, then a licensing system should be set up. This is another approach in trying to ensure that the end result of an adequately trained workforce is established through the licensing/certification process. Organizations which employ the operators may see that through certification they will have to pay more in salaries; their budgets are going to have to be higher; their service costs will be higher; and there may be a public outcry for having to pay more in taxes for vital services.

A 1976 EPA document prepared for discussion on the certification question brought out several key points concerning certification.[41] These include the following:

- The goal of certifying sanitary landfill personnel is to ensure that at least one employee of each sanitary landfill is knowledgeable in the operation. This is the only legitimate basis for establishing certification programs.
- General enforcement procedures are a more time-consuming and a more expensive strategy than certification.
- Voluntary education programs are essential to a total land disposal program but in themselves do not replace certification.
- Certification can be a valuable tool in a state's solid waste management program. It can also be very beneficial to the sanitary landfill owner by helping to assure efficient operations.
- Certification may result in a higher salary schedule for sanitary landfill employees.
- The manager or supervisor should be considered first for certification. Most state permit applications require that the person responsible for daily operations be identified.
- Different grades of certification could be based on either, or both, the size of the facility and on the kinds of wastes to be handled at the facility, i.e.,
  1.) demolition and construction only
  2.) municiple refuse, excluding hazardous wastes
  3.) hazardous wastes
- The most likely candidate for certification after the manager or supervisor is the equipment operator, who greatly affects the success of the operation.
- A certification program should require certification of managers and supervisors only, with one class of certification. Each sanitary landfill should have a certified employee on the site and in charge at all times.

- The definition of certification would be made by the state solid waste management agency and would require passing a written test. A definition of who must be certified would have to be part of the state's enabling legislation or rules and regulations.
- Although managers and supervisors would be the only personnel required to be certified, equipment operators and others should not be discouraged from acquiring certification. They are the most likely candidates for future promotion to supervisory positions.
- Seminars, workshops, and training courses are a vital part of the total certification program.
- Future training programs and any certification tests should include plan reading and simple surveying.

State Views

The State of Maryland's training officials have conducted extensive research on whether or not there is a need for state certification of solid waste personnel. These officials were aware that the federal government has considered certification for solid waste personnel, but the problem seemed to be determining who to certify. Maryland officials suggested that there is a need to certify the equipment operator at the site because he/she may also be that site's manager. In other cases, the operator may have to report to the supervisor of the site, so possibly the manager also needs to be certified. They saw as a further possibility of certifying the county or the municipal official who would be responsible for solid waste management in that particular jurisdiction. For example, an employee in the county or city government who is totally responsible for solid waste management could be certified to some extent to ensure that he/she will give proper consideration to the alternatives concerning landfill selection, collection practices, and other aspects associated with solid waste management. Quite often that person is someone who knows very little about solid waste management. Counties may need someone similar to be in charge of solid waste management and may require some type of certification. There are a few local programs in Maryland where there is an inspection of collection trucks to ensure their safe operation. It was suggested that certification should be introduced in the collection phase of the total operation.

The State of Texas has established a training and certification program for operators of municipal solid waste management facilities. They wish to see certification made mandatory for certain types and sizes of facilities and are currently trying for state legislative action. The Texas Engineering Extension Services of the Texas A & M University System has provided training in solid waste management for local community personnel for the past three years. Out of their Solid Waste Training Program has evolved a volunteer certification program which is administered by the State Health Department. The Extension Service works closely with the Texas Section of the American Public Works Association (APWA), and the Extension Service implemented an APWA certification program in the area of solid waste management in 1976. The State Health Department is interested in a certification program which would certify those persons involved in the collection, handling, and disposal of solid wastes. This mandatory certification program is envisioned to consist of two-day workshops structured as follows:

"C" Certificate-Disposal
Sanitary Landfill Operations/Management
Texas Rules and Regulations

"B" Certificate-Collection
Residential and Commercial Collection Practices
Solid Waste Collection Route Optimization
Productivity-The Motivation Crisis

"A" Certificate-Management
Sanitary Landfill Design
Solid Waste Management/Problem Solving

The Texas Engineering Extension Service plans to schedule additional workshops and skill sessions on an annual basis to keep the certificates active once mandatory legislative authority is obtained. The Extension Service also is developing a curriculum of two-day workshops for other areas of solid waste, especially those identified in RCRA. The workshops will include the following topics: Developing a State Solid Waste Plan, Developing a Regional Solid Waste Plan, Solid Waste Management System Design and Evaluation, Solid Waste Management for Local Officials, Hazardous Waste Management, and Hazardous Waste-In-Plant Management. The curriculum is designed and tested for all levels of the solid waste management industry and their workshops are conducted by industry experienced staff.

The Texas Engineering Extension Service offers a "problem clinic" for the Texas City Manager's Association. The representatives of their Association are continually concerned with the motivation of their employees, particularly those within sanitation and street departments. They view certification as an opportunity to motivate these individuals, and they offered their support to the State Department of Health Resources in attempting to obtain legislation to require mandatory certification.

Local Government Views

Representatives of Baltimore's Department of Public Works, Bureau of Sanitation, support certification for solid waste management personnel. They are **concerned** about who would conduct the training for such a program. The best training possible, in their view, would be at the job site so that the personnel there could have a more practical knowledge of proper operations. They are skeptical that a classroom-oriented program would prove valuable when compared to a program which would be structured to offer practical knowledge right at the job site. The Bureau of Sanitation representatives are concerned that if the landfill operators were certified, unions would appear and increase their demands on behalf of these people. They are also concerned about whether the person who was certified for a particular position would be flexible enough to perform jobs other than the one for which he/she was certified. They also question the availability of people who meet the certification requirements.

Officials of the American Public Works Association believe that state operator certification is needed to assure the states that there is some standardization of how landfills are operated.

Officials of The National Association of Counties' Solid Waste Project are skeptical about whether solid waste management personnel need certification. Many local governments may not be able to hire solid waste personnel if they are unable to pass a specific test. In their opinion, there is a question of what is involved in such tests. If certification gives solid waste personnel a better understanding of regulations, then they are in support of some kind of certification effort. However, certification requirements can become too formal and not be related to actual operations. There is also a question in their view as to who decides competency.

Private Sector Views

The National Solid Waste Management Association represents the private sector involvement in solid waste management activities. Officials of the Association believe that those persons involved in solid waste management in the private sector would be strongly opposed to certification for the simple reason that certification would not really increase the pool of people available to do the job. In their view, it would in fact decrease it considerably. They feel that a person should not be put in a position to be an operator simply because he/she is certified. Officials believe that there are qualified trained people to run the solid waste disposal equipment on-the-job and they feel that a certification requirement would hamper them in the performance of their jobs.

Although Association representatives are aware that certification is viewed as a means to ensure uniformity, they do not consider it to be like some of the more sophisticated sciences where rigid uniformity can be obtained, e.g., the medical field, etc. In many cases, decisions involve a subjective interpretation of regulations. Solid waste management regulations may require an educational background in hydrology, geology or the sanitary sciences to understand, but also may require a knowledge of the enforcement institution's policies and interpretations. Unless states certify personnel within their solid waste regulatory agencies and unless every state does so, association officials will continue to oppose a national certification program.

There is a continual turnover of enforcement personnel in state agencies. Association representatives consider state turnover to be an attitudinal problem and do not believe that certification would solve it. Certification would create additional problems because it would increase rigidity in occupational advancement. In other words, certification is viewed as an impediment to the labor market and industry will tend to oppose it unless a real, overriding need for it can be demonstrated.

University Views

Several professors located at universities which once were recipients of solid waste training grants were contacted and asked to express their views on whether or not there is a need for certification. Professors at the University of Michigan support the effort to develop a certification program for landfill operators but not for state enforcement personnel. Certified personnel could expect an increase in salary and a promotion via the career ladder which certification would establish. Certification may be a way of providing training for personnel of organizations such as the American Public Works Association which is financially unable to provide training for its personnel at present.

The University of Florida at Gainesville suggests that certification should be required of both operators and supervisors of solid waste facilities. This would provide the field with some stature, waste facilities. This would provide the field with some stature, establish a career ladder for the field as a whole and would improve, as it did for the wastewater field, the quality of the operations. There is a need at the state and local level for qualified and specially trained personnel to fill the places now held by untrained persons.

Officials of the Georgia Institute of Technology consider the question of certification to be premature. The expertise in the field is so limited that no one would be a qualified certifier or be able to determine the guidelines for certification.

Hofstra University representatives thought the certification of supervisors and especially operators to be an excellent idea. They suggested that the certification program now used in the State of New York for water/sewage certification should be the model used for solid wastes.

REFERENCES

1. National Academy of Sciences, Manpower for Environmental Pollution Control, Volume V (Washington: National Academy of Sciences, 1977), p. 50.

2. National Field Research Center, Inc., A National Environmental/Energy Workforce Assessment, Phase I, 70 Vols. (Iowa City, Iowa: National Field Research Center, 1977), National Abstract, p.59.

3. U.S. Environmental Protection Agency, Solid Waste Facts: A Statistical Handbook (Washington: U.S. Government Printing Office, 1978), p.7.

4. National Academy of Sciences, Manpower, pp. 54-55.

5. U.S. Department of Commerce, Bureau of the Census, Environmental Quality Control: Governmental Finances: Fiscal Year 1975-76 (Washington: U.S. Government Printing Office, 1978), p.13.

6. National Field Research Center, National Workforce Assessment, National Abstract, pp. 40-41.

7. EPA, Solid Waste Facts, p.2.

8. Applied Management Sciences, Inc., Solid Waste Management Manpower Profile and Analysis (Silver Spring, Maryland: Applied Management Sciences, 1972), Appendix B.

9. National Academy of Sciences, Manpower, p. 355.

10. U.S. Department of Commerce, Bureau of the Census, Public Employment in 1977 (Washington: U.S. Government Printing Office, 1978), pp.9-11.

11. Applied Management Sciences, Solid Waste Management Manpower, pp. 4.2-4.3.

12. National Academy of Sciences, Manpower, p.63.

13. Council on Environmental Quality, Environmental Quality: The Ninth Annual Report of the Council on Environmental Quality, (Washington: U.S. Government Printing Office, 1978), pp. 428-430.

14. Ibid, pp. 159-161.

15. U.S. Environmental Protection Agency, *Potential for Capacity Creation in the Hazardous Waste Management Service Industry* (Washington: National Technical Information Service, 1976), p. 21.

16. U.S. Environmental Protection Agency, "Implementation Planning Document, Section 7007. Grants or Contracts for Training Projects."

17. Steffen W. Plehn, "OSW Senior Staff Meeting on Manpower Development and Training Policy and Program", Memorandum, April 17, 1978.

18. Carol S. Lawson, "Implementation of Section 7007", Memorandum, March 23, 1978.

19. Tommie A. Gibbs, Solid Waste Management *Strategy for Manpower Development/Training* (Washington: U.S. Environmental Protection Agency, 1977), p. vi.

20. U.S. Environmental Protection Agency, *Water Quality Control Training Courses: October 1978 Through September 1979* (Cincinnati: U.S. Environmental Protection Agency, 1978), p.11.

21. U.S. Environmental Protection Agency, "Technology Transfer Holds An Additional Municipal Design Seminar on Sludge Treatment and Disposal," *Technology Transfer* (October, 1978): 8.

22. U.S. Environmental Protection Agency, "12-Point Document: Preparation of a Regulation Information Program for Generators and Transporters of Hazardous Wastes", p. 2.

23. U.S. Environmental Protection Agency, *Discussion of FY 77 Training Grants* (Washington: U.S. Environmental Protection Agency, 1976), p. 1.

24. Ibid., p.2.

25. Gibbs, *Solid Waste Management Strategy*, pp. 26-27.

26. U.S. Environmental Protection Agency, "Guidelines for Development and Implementation of State Solid Waste Management Plans", *Federal Register* 431 No. 167, August 28, 1978, 38535.

27. U.S. Environmental Protection Agency, *Manpower Development Policy Paper (Draft)* (Washington: U.S. Environmental Protection Agency, 1978), pp. 11-12.

28. Thomas Anderson et al., *The States' Roles in Solid Waste Management: A Task Force Report* (Lexington, Kentucky: The Council of State Governments, 1973), p.ix.

29. Applied Management Sciences, Solid Waste Management Manpower, p. 9.4.

30. Department of Commerce, Public Employment, p. vi.

31. National Academy of Sciences, Manpower, p.6.

32. Ibid., p.4.

33. U.S. Environmental Protection Agency, Draft Background Document, Section 250. 43-4, Standards for Training (Washington: U.S. Environmental Protection Agency, 1978), pp. 17-19.

34. U.S. Environmental Protection Agency, Training and Manpower Development Considerations in Hazardous Waste Management (Washington: U.S. Environmental Protection Agency, 1974), pp. 1-5.

35. Steffen W. Plehn, "Resource Conservation and Recovery Act: An Update", Address to the American Public Works Association, October 16, 1978.

36. U.S. Environmental Protection Agency, EPA Activities Under the Resource Conservation and Recovery Act of 1976 (Washington: U.S. Environmental Protection Agency, 1978), p.34

37. EPA, Draft Background Document, Section 250-43-4, pp. 17-19.

38. EPA, Potential For Capacity Creation, Bibliography Data Sheet.

39. EPA, "Guidelines", Federal Register, 38538

40. National Academy of Sciences, Manpower, p. 419.

41. Thomas D. Gillard, Certification and Training of Sanitary Landfill Employees (Kansas City: U.S. Environmental Protection Agency, 1974), pp. 1-18.

APPENDICES

A. SAUGUS, MASSACHUSETTS RESOURCE RECOVERY PLANT

JOB DESCRIPTIONS

Plant Manager

. . Qualifications:

Degrees in engineering or equivalent.

Knowledge and experience in the management and maintenance of thermal power plants (generating stations, district heating).

Organizational ability and experience in the supervision of personnel and administration.

. . Duties:

Responsible for plant management, plant maintenance, and administration.

Work schedule.

Supervision and training.

Hiring.

Plant Engineer - Maintenance Supervisor

. . Qualifications:

Trained mechanic, fitter, or electrician with qualifying reference, full journeyman's rating desirable.

Familiarity with maintenance and repair of electro-mechanical plant installations.

Organizational ability and experience in personnel supervision.

First class engineers' license issued by the State of Massachusetts (minimum).

. . Duties:

Assists plant manager; assumes duties of plant manager in his/her absence.

Supervises maintenance personnel.

Organizes maintenance and repair work.

Responsible for workshop, warehouse, and spare parts stock.

Shift Foreman

. . Qualifications:

Trained mechanic and fitter with qualifying reference.

Courses in power plant operation and maintenance.

Experience in operation and maintenance of boiler installations.

Second class engineers' license issued by the State of Massachusetts.

. . Duties:

Supervises shift; responsible for all work necessary to ensure smooth operation.

Controls and determines method of operation.

Monitors water analyses.

Responsible for shift log.

Supervises plant practices and procedures.

Responsible for alarms, regulators, and instruments.

Responsible for water treatment plant.

Personal inspection of plant.

Relieves boiler operator/control room operator if required.

Gives assistance during repairs, maintenance, and cleaning work.

Security Guard

. . Qualifications:

Knowledge in plant security procedures.

. . Duties:

Serves as plant guard at main truck entrance gate; responsible for plant security during his tour of duty; keeps all security records and carries out plant manager's instructions on personnel access.

Directs traffic into and out of plant.

Performs routine administrative duties as directed by plant manager or plant engineer.

Reception Area Floorman

. . Qualifications:

Ability to communicate with truck drivers, direct traffic, and manage the delivery of refuse trucks arriving at rates up to 20 per hour.

Ability to determine general nature of refuse being delivered.

Ability to operate front-end loader to clean-up refuse on floor and dump it into storage pit.

. . Duties:

Determines type of refuse being delivered and directs trucks to discharge into storage pit or on floor as required for best operations of the plant.

Operates front-end loader to clean-up floor as required.

Coordinates his/her work with crane operator, and boiler operator to assure steady flow of fuel to the furnaces.

Crane Operator

. . Qualifications:

A qualified industrial plant crane operator.

Knowledge and understanding of industrial plant safety procedures and operating practices.

Ability with operation and maintenance of machines and electrically operated equipment.

. . Duties:

Operates overhead crane; charges furnaces according to operating instructions.

Keeps regular contact with shift foreman, floorman, and boiler operator; exchanges information with regard to refuse quality and quantity (mixing or refuse).

Controls and maintains crane installation according to operating instructions and lubrication chart.

Cleans crane control cabin.

Assists with crane repairs.

Boiler Operator

. . Qualifications:

Trained mechanic or fitter with qualifying reference.

An instruction course in heating and plant operation is required; experience in operation and maintenance of boiler installations mandatory. The equivalent of a second class engineers' license is desirable.

. . Duties:

Responsible for operation of furnace-boiler unit according to instructions with regard to firing.

Controls grate function.

Constant monitoring of refuse quality.

Controls clinker chute.

Communicates regularly with crane operator for information on refuse quality.

Assists with repairs and maintenance.

Control Room Operator

. . Qualifications:

Trained mechanic or fitter with qualifying reference,

An instruction course in heating and plant operation is required; experience in operation and maintenance of boiler installation is mandatory. A second class engineers' license is desirable.

. . Duties:

Controls boiler operation.

Responsible for furnace, boiler, electrostatic precipitator, and oil burner operation.

Communicates regularly with crane operator on refuse quality.

Assists with repair and maintenance.

Metal Recovery Operator

. . Qualifications:

Qualified industrial plant workman with knowledge of plant operating and safety procedures.

Experience with the operation of machines and equipment commonly found in heavy industrial plants.

. . Duties:

Operates materials conveyors, feeders, and magnetic separators.

Checks operation of equipment for smooth flow of materials, malfunctions, or breakdowns.

Monitors materials recovered and materials handling vehicles; prevents overloading.

Clean-Up Man

. . Qualifications:

Knowledgeable in plant operating and safety procedures.

Ability to operate small in-plant materials handling vehicles.

. . Duties:

Operates machines designed to clear reception area floor of refuse.

Relieves reception area floorman as required.

Cleaning work on furnaces and in boiler house as well as precipitator, etc.

Assisting with repair work.

Performs janitorial work.

Operating ash handling equipment.

Pipefitter-Welder

. . Qualifications:

Trained mechanic or fitter with qualifying reference.

Trained in gas and electro-welding.

. . Duties:

Maintenance and service of electro-mechancial equipment.

Repairs and revisions in the plant (together with shift personnel).

Welding, pipefitting and maintenance shop work.

Responsible for warehouse and maintenance shop as well as mechanical spare parts.

Instrument and Controls Technician

. . Qualifications:

Knowledge and ability to repair pneumatic and electronic instrument systems.

Special experience with instrumentation required for operation of a steam power plant.

. . Duties:

Preventive maintenance of instrumentation systems throughout the plant, including functioning and calibration.

Serves as troubleshooter in the instrumentation system.

Maintains instrument supplies, spares, and workshop in proper condition to serve the plant.

Assists other maintenance personnel as may be required to keep plant in good working condition.

Millwright-Mechanic

. . Qualifications:

Trained mechanic, fitter, or electro-mechanic with qualifying reference.

Experience in operation and maintenance of steam boiler plants or thermal power plants is desirable.

. . Duties:

Repair and service turbines, pumps, heat exchangers, and compressors.

Maintenance and repair of piping, motors, and machinery.

Makes preventive maintenance checks according to operating instructions.

Lubricates as necessary.

Assists with repair, maintenance, and cleaning work.

Maintenance, and cleaning of ash handling equipment.

Electrician

. . Qualifications:

Trained electrician with qualifying reference.

The equivalency of a journeyman electrican in work experience.

. . Duties:

Maintains and services electrial equipment.

Repairs and revisions to electrial installations and equipment.

Responsible for electrical spare parts.

Mobile Equipment Mechanic

. . Qualifications:

Knowledge of repair and maintenance procedures for heavy duty industrial vehicles.

. . Duties:

Maintenance of plant trucks, tractors, trailers, and other vehicles.

Keeps stock of spare parts for vehicle maintenance.

Keeps maintenance shop in good condition.

Dispatcher

. . Qualifications:

Knowledgeable in trucking operations and clerical duties.

Ability to organize and manage a truck dispatching service.

. . Duties:

Organizes and manages truck dispatching service for the system.

Assists plant manager in administrative duties as directed.

Truck Driver

. . Qualifications:

Operator's licenses for operation of heavy duty vehicles, both state and ICC as required.

Knowledge of operating and safety procedures for tractor-trailer and truck operations.

. . Duties:

Drives truck or tractor hauling refuse or ash.

Obeys all state and local laws pertaining to traffic control and operates his vehicle in a safe manner at all times.

Accountant

. . Qualifications:

Bachelor's degree in accounting or equivalent work experience in business accounting procedures.

Ability to develop accounting procedures for the system to obtain required data to make accounting analyses and submit proper reports to the plant manager.

. . Duties:

Develops accounting procedures for the plant, transfer stations, and energy and material customers.

Keeps required accounting and payroll records, makes analyses, and prepares reports for plant manager.

Performs other duties as directed by the plant manager.

Laboratory Technician

. . Qualifications:

Bachelor's degree in chemistry or equivalent work experience in chemical analysis.

Knowledge of chemical analysis techniques and requirements for analyzing the plant's water supply, boiler feedwater water treatment system, and plant wastewater quality.

. . Duties:

Makes analysis of all plant influent and effluent water streams.

Analyzes plant boiler feedwater.

Reports any marginal or off-limit conditions to the proper person in the plant so that corrective action can be taken.

Performs other laboratory work as directed by the plant engineer.

Secretary-Receptionist

. . Qualifications:

High school equivalency with courses in typing, shorthand, and secretarial work.

Ability to serve as secretary to plant manager and to act as receptionist in plant office.

. . Duties:

Perform all normal secretarial duties for the plant manager.

Meet visitors, handle communications with plant personnel, and create a favorable impression upon visitors to the plant.

B. SOLID WASTE TRAINING GRANT AWARDS TO STATE AND LOCAL AGENCIES

Many of the agencies appear more than once because the list represents yearly changes in the funding, e.g., new, continuation, increase, decrease, renewal, etc.

1971

Montana Department of Health and Environment
Montana Solid Waste Training Project
Project Period: 7/1/71 to 12/31/73

1972

Tennessee Department of Public Health
Solid Waste Training Grant
Project Period: 7/1/71 to 3/31/74

Ohio Department of Health
Renewal Ohio Solid Waste Training Project Grant
Project Period: 9/1/72 to 8/31/73

New Mexico Environmental Improvement Agency
Solid Waste Management Training
Project Period: 9/1/72 to 8/31/75

New York Department of Environmental Conservation
New York State Solid Waste Training Grant
Project Period: 7/1/69 to 3/31/74

Colorado Department of Health
Operators & Supervisors/Disposal Sites & Facilities
Project Period: Unknown

Maryland Environmental Health Service
Comprehensive Solid Waste Training Program for Maryland
Project Period: 7/1/71 to 6/30/73

Missouri Division of Health
Missouri Solid Waste Management Training Project
Project Period: 9/1/72 to 8/31/74

Kentucky State Department of Health
On the Job Training Project
Project Period: 7/1/72 to 12/31/73

Minnesota Pollution Control Agency
Solid Waste Training Grant
Project Period: 3/1/72 to 6/30/74

City of Los Angeles
Summer Program for Action to Renew the Environment
Project Period: Unknown

City of Anchorage
Summer Program for Action to Renew the Environment
Project Period: 6/5/72 to 6/4/73

1973

Missouri Division of Health
Missouri Solid Waste Management Training Project
Project Period: 9/1/72 to 6/31/74

New Mexico Health and Social Services Department
Solid Waste Management Training
Project Period: 9/1/72 to 8/31/75

Colorado Department of Health
Solid Waste Management Training Project
Project Period: 2/1/73 to 6/30/74

Minnesota Pollution Control Agency
Minnesota Solid Waste Training Grant
Project Period: 3/1/72 to 6/30/74

Government of the Virgin Islands
U.S. Virgin Islands Solid Waste Management Public Education Program
Project Period: 12/1/73 to 1/11/74

1974

Maryland Environmental Health Services
Comprehensive Solid Waste Training Program for Maryland
Project Period: 7/1/71 to 6/30/73

Ohio Environmental Protection Agency
Ohio Solid Waste Disposal Training Project Grant
Project Period: 7/1/73 to 12/31/74

Kentucky Department of Natural Resources
State of Kentucky On-the-Job Training Project
Project Period: 1/1/73 to 12/31/73

Kentucky Department of Natural Resources
SPARE (Summer Program for Action to Renew the Environment)
Project Period: 1/1/73 to 12/31/73

Colorado Department of Health
Solid Waste Management Training Project
Project Period: Unknown

1975

District of Columbia Government
TV Spots for Public Service Announcement in Solid Waste
Project Period: 10/20/75 to 3/19/76

Idaho State Department of Education
Summer Program for Action to Renew the Environment
Project Period: Unknown

Colorado Department of Health
Solid Waste Management Training Project
Project Period: Unknown

1976

New Mexico Health and Social Services Department
Project Period: Unknown

City of Philadelphia
Training Program for Operating Supervisors in the Use of the Sanitation Management Information System
Project Period: 7/1/76 to 6/30/78

C. TRAINING PROGRAMS SPONSORED BY PRIVATE SECTOR ORGANIZATIONS

American Institute for Research, Education and Training, Washington, D.C.
    Solid Waste Management Project

American Public Health Association, Washington, D.C.
    RCRA for Health and Environmental Personnel

American Public Works Associations, Chicago, IL
    Updating and Revising the Authoritative Text, "Refuse Collection Practice"
    Provide Increased Solid Waste Management Services to State and Local Agencies

American Association of State Colleges and Universities, Washington, D.C.
    Planning Program for a National Cooperative Program in the Environment; Manpower, Training and Education

Children's Museum, Boston, MA
    Industrial Wastes Generation and Disposal

Conservation Foundation, Washington, D.C.
    Citizen Education Project on Solid Waste Management

Economic Opportunity - Atlanta, GA
    Summer Program for Action to Renew the Environment

Environmental Action Coalition, Inc., New York, NY
    "Trash is Cash" Recycling Training Film
    Extra Information Footage to the Film "The Village Green"
    Education and Action Program in Solid Wastes, Recycling and Resource Recovery

Environmental Action Foundation, Inc., Washington, D.C.
    Citizen Education Project
    Citizen Solid Waste Communication Newtwork
    Citizen Assistance to State Implementation of RCRA

Environmental Policy Institute, Washington, D.C.
    Hazardous Materials Disposal Workshops

Government Refuse Collection and Disposal Association, San Leandro, CA
    Technical Assistance and Training Program for RCRA

International City Management Association, Washington, D.C.
Solid Waste Information and Training Program
Solid Waste Information Training Program for Local Government Chief Administrative Officers
Solid Waste Technical Assistance for Local Government Managers

Izaak Walton League of America, Arlington, VA
Municipal Sludge and RCRA

League of Women Voters - Education Fund, Washington, D.C.
Solid Waste Training Program for State Leaders
Citizen Education and Training Project on Solid Waste Management
Citizen Education and Activities in Solid Waste Management
Hazardous Waste Legislature Conference
Public Education to Support Hazardous and Solid Waste Management

National Academy of Sciences, Washington, D.C.
Conference on Solid Waste Management in Buildings

National Association of Counties Research Foundation, Washington, D.C.
Technical Assistance for Counties in Solid Waste Management

National Association of Regional Councils, Washington, D.C.
Regional Councils and Solid Waste Management

National Governor's Conference, Washington, D.C.
State Initiatives Toward Implementation of RCRA

National League of Cities - U.S. Conference of Mayors, Washington, D.C.
Solid Waste Management Program
Solid Waste Management Project
Resource Conservation Committee Public Participation

National Solid Waste Management Association, Washington, D.C.
Solid Waste Financing and Operator Efficiency Seminar

National Wildlife Federation, Washington, D.C.
Integrated Solid Waste Management and the Rule of Landfills
Rural Solid Waste Management Education Programs
RCRA State Public Education Forums

Ohio Environmental Council, Columbus, OH
Conference: Hazardous Waste Management in the State of Ohio

Oil, Chemical, and Atomic Workers Union, Washington, D.C.
Solid Waste Education Project
Hazardous Wastes Educational Program

Pennsylvania Environmental Council, Philadelphia, PA
    Hazardous Wastes Management Seminars
    Hazardous Wastes Management, Legislative - Administrative Public Forum

Portland Recycling Team, Inc., Portland, OR
    History of an Urban Recycling Program and Operating a Recycling Project Manual

St. Louis Regional Chamber of Commerce, St. Louis, MO
    First National Industrial Waste Exchange Seminar

Scientists Committee for Public Information, New York, NY
    Hazardous Wastes Conference

Scientists Institute for Public Information, New York, NY
    Solid Waste Management Public Workshop Program

Sierra Club Foundation, San Francisco, CA
    Environmental Parameters of Solid Waste

Technical Information Project, Washington, D.C.
    Citizen Solid Waste Education Program
    Heightening Public Awareness of Municipal Land Disposal Problems

West Michigan Environmental Action Education Foundation, Grand Rapids, MI
    Citizen Education and Activity

D. SOLID WASTE TRAINING GRANT AWARDS TO UNIVERSITY ACADEMIC PROGRAMS

Many of the universities appear more than once because the list represents yearly changes in the funding, e.g., new, continuation, increase, decrease, renewal, etc. A total of 14 universities received EPA solid waste academic training grants.

1968

University of Illinois
  Solid Waste Management
  Project Period: 7/1/68 to 8/31/73

1971

Rensselaer Polytechnic Institute
  Solid Waste Engineering
  Project Period: 9/1/67 to 12/31/72

University of Florida
  Solid Waste
  Project Period: 7/1/72 to 6/30/73

1972

West Virginia University
  Graduate Training Program in Solid Waste Management
  Project Period: 7/1/67 to 6/30/73

  Training Waste Water Control and Reclamation
  Project Period: 7/1/69 to 8/31/74

  Solid Waste Training Program
  Project Period: 7/1/67 to 5/31/75

University of Wisconsin
  Training in Solid Wastes Engineering and Management
  Project Period: 7/1/67 to 6/30/78

Cornell University
  Management of Animal Waste
  Project Period: Unknown

University of Washington
  Solid Wastes Management and Utilization
  Project Period: 7/1/72 to 9/30/76

Georgia Institute of Technology
    Solid Waste Technology
    Project Period: 7/1/72 to 6/30/76

University of Oklahoma
    Environmental Management - Solid Waste
    Project Period: 7/1/70 to 8/31/74

University of Southern California
    Training in Solid Waste Management
    Project Period: 7/1/71 to 9/30/74

University of Iowa
    Solid Waste Management
    Project Period: 7/1/71 to 6/30/75

University of Hawaii
    Training in Solid Waste Collection and Disposal
    Project Period: 7/1/72 to 8/31/75

1973

West Virginia University
    Solid Wastes Training Program
    Project Period: 7/1/67 to 5/31/75

University of Wisconsin
    Training in Solid Wastes Engineering and Management
    Project Period: 7/1/71 to 6/30/74

University of Oklahoma
    Environmental Management of Solid Waste
    Project Period: 7/1/70 to 8/31/74

George Washington University
    Community Support for Solid Waste Management
    Project Period: 6/1/73 to 5/31/75

University of Iowa
    Solid Waste Management
    Project Period: 7/1/71 to 6/30/75

University of Southern California
    Professional Training in Solid Waste Management
    Project Period: 7/1/71 to 9/30/74

University of Hawaii
    Training in Solid Waste Collection and Disposal
    Project Period: 7/1/72 to 6/30/74

University of Cincinnati
    Summer Institute in Environmental Education
    Project Period: 4/1/73 to 8/31/74

Georgia Institute of Technology
    Solid Waste Technology
    Project Period: 7/1/72 to 6/30/75

University of Washington
    Solid Waste Management and Utilization
    Project Period: 7/1/72 to 9/30/75

1974

University of Illinois
Solid Waste Management
Project Period: 7/1/68 to 8/31/73

Rensselaer Polytechnic Institute
    Solid Waste Engineering
    Project Period: 7/1/71 to 12/31/72

1975

University of Cincinnati
    Summer Institute in Environmental Education
    Project Period: Unknown

1978

Georgia Institute of Technology
    Solid Waste Technology
    Project Period: Unknown

E. COLLEGES AND UNIVERSITIES

OFFERING SOLID WASTE MANAGEMENT TRAINING

ALABAMA	
school	University of Alabama
department	Civil Engineering
program/emphasis	Solid Waste emphasis
level	Graduate
ALASAKA	University of Alaska School of Engineering Environmental Quality Engineering Solid Waste Management concentration Graduate
ARKANSAS	Southwest Technical Institute Environmental Control Technology Solid Waste Management emphasis 2 year
	University of Arkansas College of Agriculture/Home Economics/Arts & Science/Engineering Environmental Science/Engineering Graduate
CALIFORNIA	Humboldt State University Engineering Solid Waste emphasis 4 year
	California State University Civil Engineering 4 Year and Graduate
COLORADO	Community College of Denver Service Operations Division Solid Waste emphasis 2 year
CONNECTICUT	University of Connecticut Civil Engineering Solid Waste emphasis Graduate

CONNECTICUT (cont'd)

school	University of Hartford
department	College of Engineering
program/emphasis	Solid Waste Management
level	Graduate

Yale University
Epidemiology and Public Health
Solid Waste emphasis
Graduate

DISTRICT OF COLUMBIA

George Washington University
Civil Engineering
Environmental Option
4 year and Graduate

Howard University
Civil Engineering
Environmental Option
4 year and Graduate

FLORIDA

University of Florida
Environmental Engineering Sciences
Systems Ecology/Environmental Resources Management
Graduate

GEORGIA

Fort Valley State College
Agricultural Engineering
Agricultural Waste Management
4 Year

Georgia Insititue of Technology
Civil Engineering
Solid Waste Technology
Graduate

HAWAII

University of Hawaii at Manoa
Public Health Sciences
Graduate

IDAHO

University of Idaho
Civil Engineering
4 year and Graduate

ILLINOIS

University of Illinois
Civil Engineering
Environmental Engineering
Specialty in Solid Wastes
Graduate

IOWA

school	University of Iowa
department	Division of Energy Engineering
program/emphasis	Environmental Engineering
level	4 year and Graduate

KANSAS

University of Kansas
Civil Engineering
Environmental Health Engineering/Science
Solid Waste Disposal
Graduate

KENTUCKY

University of Louisville
Chemical and Environmental Engineering
Environmental Engineering
4 year and Graduate

LOUISIANA

McNeese State University
Microbiology
Environmental Science
4 year and Graduate

University of Louisiana
Chemical and Environmental Engineering
Solid Waste emphasis
4 year and Graduate

MASSACHUSETTS

Northeastern University
Civil Engineering
Cooperative Program in Solid Waste
5 year

Northern Essex Community College
Division of Engineering and Technical Studies
Solid Waste Disposal Emphasis
2 year

MICHIGAN

Michigan Technological University
Civil Engineering
Environmental Engineering
Solid Waste Disposal Concentration
4 year and Graduate

University of Michigan
Civil Engineering
Solid Waste
Graduate

MISSOURI	
school	University of Missouri at Rolla
department	Civil Engineering
program/emphasis	Environmental and Sanitary Engineering Solid Waste Management Option
level	Graduate
NEW HAMPSHIRE	University of New Hampshire Civil Engineering Solid Waste emphasis 4 year and Graduate
NEW JERSEY	New Jersey Institute of Technology Interdepartmental Interdisciplinary Studies in Environmental Engineering Solid Waste Management Specialization Graduate
	Rutgers Environmental Science Environmental Science Graduate
	Stevens Institute of Technology Mechanical Engineering Environmental Engineering/Science Speciality in Solid Waste Management and Resource Recovery Graduate
NEW MEXICO	University of New Mexico Civil Engineering Solid Waste Disposal emphasis 4 year and Graduate
NEW YORK	Clarkson College Civil and Environmental Engineering Solid Waste emphasis 4 year and Graduate
	Cornell University College of Agriculture and Life Sciences Waste Management Engineering Graduate

NEW YORK (cont'd)

school	Cornell University
department	Environmental Engineering
program/emphasis	Environmental Engineering
level	Graduate

Hofstra University
Continuing Education
Certificate

Hunter College
School of Health Sciences
Environmental Health Services
Graduate

Polytechnic Institute of New York
Civil and Environmental Engineering
Environmental Engineering and Planning
Graduate

Rensselaer Polytechnic Institute
Chemical and Environmental Engineering
Environmental Engineering/Solid Waste Option
Graduate

Syracuse University
Civil Engineering
Graduate

NORTH CAROLINA

Duke University
Civil Engineering
Resource Recovery Engineering
Graduate

Duke University
Environmental Health
Environmental Health
Solid Waste Specialist Option
Graduate

University of North Carolina
Environmental Science and Engineering
Environmental Management and Protection
Graduate

NORTH DAKOTA

school	North Dakota State School of Science
department	Technical Division
program/emphasis	
level	2 year

OHIO

Ohio State University
Agricultural Engineering
Agricultural Engineering
Graduate

Ohio State University
Civil Engineering
Sanitary and Environmental Engineering
Graduate

University of Cincinnati
Civil and Environmental Engineering
Specialization in Solid Waste Control
Graduate

University of Toledo
Chemical Engineering/Civil Engineering
Biochemical Engineering
Graduate

OKLAHOMA

Oklahoma State University
Civil Technology
2 year

University of Oklahoma
Civil Engineering and Environmental Science
Environmental Science
Speciality in Solid Waste Management and Design
4 year and Graduate

PENNSYLVANIA

Carnegie-Mellon University
Carnegie Institute of Technology
Civil Engineering
Environmental Engineering
4 year and Graduate

PENNSYLVANIA (cont'd)

school	department	program/emphasis	level
Drexel University Institute for Environmental Studies	Environmental Engineering and Science	Solid Wastes Concentration	Graduate
Lehigh University	Civil Engineering	Environmental Health Engineering	4 year and Graduate
Northhampton County Area Community College	Environmental Studies	Solid Waste Disposal emphasis	2 year
Pennsylvania State University	Civil Engineering	Environmental Engineering Specialization in Solid Wastes	Graduate
Pennsylvania State University	Intercollege	Environmental Pollution Control Option in Environmental Resource Management; Land Environment	Graduate
Temple University	College of Engineering Technology	Solid Waste Management	2 and 4 year
University of Pittsburgh	Civil Engineering	Emphasis on Solid Wastes Disposal	4 year and Graduate
Westmoreland County Community College	Conservation and Environmental Technology	Solid Waste Disposal	2 year

RHODE ISLAND

school	University of Rhode Island
department	Civil and Environmental Engineering
program/emphasis	Solid Waste Disposal and Management
level	4 year and Graduate

SOUTH CAROLINA

Clemson University
Agricultural Engineering
Agricultural Waste Management
4 year

TENNESSEE

Memphis State University
Civil Engineering
Solid Waste Management
Graduate

University of Tennessee at Knoxville
Civil Engineering
Environmental Engineering
Speciality in Solid Waste Management
4 year and Graduate

Vanderbilt University
Environmental Engineering and Policy Management
Environmental and Water Resources Engineering/Solid Waste Option
4 year and Graduate

TEXAS

Texas A & M University
Civil Engineering
Environmental Engineering
Solid Waste Management Concentration
4 year and Graduate

University of Houston
Community Health Sciences
4 year and Graduate

University of Texas
Community Health Sciences
Graduate

UTAH

University of Utah
Civil Engineering
Environmental Engineering
Solid Waste Mangement Option
Graduate

UTAH (cont'd)

school	Utah State University
department	Civil and Environmental Engineering
program/emphasis	
level	4 year and Graduate

VERMONT

University of Vermont
Civil Engineering
Solid Waste Management
4 year

VIRGINIA

Virginia Polytechnic Institute and State University
Civil Engineering
Sanitary Engineering/Environmental Science
Graduate

Wytheville Community College
Environmental Technology
Solid Waste Management
2 year

WEST VIRGINIA

West Virginia Northern Community College
Occupational Safety and Environmental Hygiene
Environmental Sanitation
2 year and Certificate

West Virginia University
Civil Engineering
Environmental Engineering
Speciality in Solid Waste Management
Graduate

WISCONSIN

University of Wisconsin at Green Bay
College of Environmental Science
Waste Management and Resource Recovery
Graduate

University of Wisconsin at Madison
Civil and Environmental Engineering
Civil and Environmental Engineering
Solid Waste Disposal Option
4 year

F. BIBLIOGRAPHY

American Public Works Association. Blueprint for a Comprehensive Solid Waste Training Program. Chicago: American Public Works Association, 1968.

Anderson, Thomas; Andres, D. R.; Brown, J.; Gershowitz, H.; Jensen, T.; Johnston, G.N.; McIntosh, C.P.; Quinn, R.H.; and Record, J. The States' Roles in Solid Waste Management: A Task Force Report. Lexington, Kentucky: The Council of State Governments, 1973.

Applied Management Sciences, Inc. Solid Waste Management Manpower Profile and Analysis. Silver Spring, Maryland: Applied Management Sciences, 1972.

Charles County Community College. A Solid Waste Technology Program. LaPlata, Maryland: Charles County Community College, 1973.

Council on Environmental Quality. Environmental Quality: The Ninth Annual Report of the Council on Environmental Quality. Washington: U.S. Government Printing Office, 1978.

Gibbs, Tommie A. Solid Waste Management Strategy for Manpower Development/Training. Washington: U.S. Environmental Protection Agency, 1977.

Gillard, Thomas D. Certification and Training of Sanitary Landfill Employees. Kansas City: U.S. Environmental Protection Agency, 1976.

Gillard, Thomas D. Solid Waste Training; Project Transition. Kansas City: U.S. Environmental Protection Agency, 1973.

Lawson, Carol S. "Implementation of Section 7007". Memorandum, March 23, 1978.

National Academy of Sciences. Manpower for Environmental Pollution Control, Volume V. Washington: National Academy of Sciences, 1977.

National Field Research Center, Inc. A National Environmental/Energy Workforce Assessment, Phase II, Postsecondary Education Profile. Iowa City, Iowa: National Field Research Center, Inc., 1978.

National Field Research Center, Inc. A National Environmental/Energy Workforce Assessment, Phase I. Iowa City, Iowa: National Field Research Center, Inc., 1977.

National Field Research Center, Inc. A Workforce for Environment and Energy: A Master Plan for Environmental/Energy Higher Education in Illinois. Iowa City, Iowa: National Field Research Center, Inc., 1975.

Plehn, Steffen W. "OSW Senior Staff Meeting on Manpower Development and Training Policy and Program". Memorandum, April 17, 1978.

Plehn, Steffen W. "Resource Conservation and Recovery Act : An Update". Address to the American Public Works Association, October 16, 1978.

Sen, Satyakam. Survey of Environmental Technician Employment Needs in Solid Waste Occupations. Hartford, Connecticut: Connecticut State Department of Education, Division of Vocational Education, Research and Planning Unit, 1977.

Townley, Donald A. Solid Waste Management Training Needs. Kansas City: U.S. Environmental Protection Agency, 1973.

U.S. Department of Commerce, Bureau of the Census. Environmental Quality Control: Governmental Finances: Fiscal Year 1975-76. Washington: U.S. Government Printing Office, 1978.

U.S. Department of Commerce, Bureau of the Census. Public Employment in 1977. Washington: U.S. Government Printing Office, 1978.

U.S. Department of Commerce, Bureau of the Census. Statistical Abstract of the United States. Washington: U.S. Government Printing Office, 1974.

U.S. Department of Commerce, Bureau of Economic Analysis. Capital Expenditures by Business for Pollution Abatement, 1973-77 and Planned 1978. Washington: U.S. Department of Commerce, 1978.

U.S. Department of Labor, Bureau of Labor Statistics. Impact of Federal Pollution Control and Abatement Expenditures on Manpower Requirements. Washington: U.S. Government Printing Office, 1975.

U.S. Environmental Protection Agency. Discussion of FY 77 Training Grants. Washington: U.S. Environmental Proteciton Agency, 1976.

U.S. Environmental Protection Agency. Draft Background Document, Section 250. 43-4, Standards for Training. Washington, U.S. Environmental Protection Agency, 1978.

U.S. Environmental Protection Agency. EPA Activities Under the Resource Conservation and Recovery Act of 1976. Washington: U.S. Environmental Protection Agency, 1978.

U.S. Environmental Protection Agency. "Guidelines for Development and Implementation of State Solid Waste Management Plans". *Federal Register* 43, No. 167, August 28, 1978.

U.S. Environmental Protection Agency. "Implementation Planning Document, Section 7007. Grants or Contracts for Training Projects".

U.S. Environmental Protection Agency. *Manpower Development Policy Paper (Draft)*. Washington: U.S. Environmental Protection Agency, 1978.

U.S. Environmental Protection Agency. *Potential for Capacity Creation in the Hazardous Waste Management Service Industry*. Washington: National Technical Information Service, 1976.

U.S. Environmental Protection Agency. *Research, Demonstration, Training, and Fellowship Awards*. Washington: U.S. Environmental Protection Agency, 1977.

U.S. Environmental Protection Agency. *Solid Waste Facts: A Statistical Handbook*. Washington: U.S. Government Printing Office, 1978.

U.S. Environmental Protection Agency. "Technology Transfer Holds an Additional Municipal Design Seminar on Sludge Treatment and Disposal". *Technology Transfer*, October, 1978.

U.S. Environmental Protection Agency. *Training and Manpower Development Considerations in Hazardous Waste Management*. Washington: U.S. Environmental Protection Agency, 1974.

U.S. Environmental Protection Agency. "12-Point Document" Preparation of A Regulation Information Program for Generators and Transporters of Hazardous Wastes".

U.S. Environmental Protection Agency. *Water Quality Control Training Courses: October 1978 Through September 1979*. Cincinnati: U.S. Environmental Protection Agency, 1978.

Vesilind, P. Aarne; Pearsall, G.W.; Dajani, J.S.; Warner, D.: and Rimer, A.E. *A Curriculum Option in Resource Recovery Engineering*. Durham, North Carolina: Duke University, 1977.

Weiner, Lawrence A. *Training for Hazardous Waste Facility Personnel (Draft)*. Washington: U.S. Environmental Protection Agency, 1977.